JOURNAL OF THE

SMPTE

89th SMPTE Convention • May 7–12 • King Edward Sheraton, Toronto

volume 69 • number 10 **OCTOBER 1960**

JOURNAL of the
SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

PUBLICATION OFFICE TWENTIETH AND NORTHAMPTON STREETS EASTON, PA.

. . .

Subscriptions to nonmembers, $12.50 a year (outside continental United States, add $1.00 for postage); subscribers residing in countries which participate in UNESCO may use UNESCO coupons in submitting subscription payments in the event other means of remitting are not available; single copies, $2.00 for one-part issues, $2.50 for special two-part issues. A 10% discount is allowed to individual members and accredited agencies on orders for subscriptions and single copies. A list of priced and gratis publications is available. Order from the Society's Headquarters Office, 55 West 42d St., New York 36.

. . .

THE SOCIETY is the growth of over forty years of achievement and leadership. Its members are engineers and technicians skilled in every branch of motion-picture film production and use, in television, and in the many related arts and sciences. Through the Society they are able to contribute effectively to the technical advance of their industry. The Society was founded in 1916 as the Society of Motion Picture Engineers and was renamed in 1950.

Membership in Sustaining, Active, Associate or Student grades is open to any interested person according to his qualifications. Information about membership, technical activities and standards and test films for the industry is available from Society Headquarters. Members residing in countries which participate in UNESCO may use UNESCO coupons in submitting membership payment in the event other means of remitting are not available.

SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

Headquarters Office: 55 West 42d St., New York 36, N.Y. Cables: Somopict Telephone: LOngacre 5-0172

Executive Secretary: CHARLES S. STODTER

Published monthly by the Society of Motion Picture and Television Engineers. Publication office 20th and Northampton Sts., Easton, Pa. Second-class mail privileges authorized at Easton, Pa. This publication is authorized to be mailed at the special rates of postage prescribed by Section 132.122.

Printed by Mack Printing Company, Easton, Pa.

Journal of the
Society of Motion Picture
and Television Engineers

VOLUME 69 · NUMBER 10 · OCTOBER 1960

Fiber Optics — A New Tool in Electronics

By L. J. KROLAK,
W. P. SIEGMUND
and R. G. NEUHAUSER

Fiber optics — the technology of transmitting element-by-element a light image from one point to another — solves many knotty problems where photometric efficiency is at a premium and flexibility in design is important. Fiber optic bundles, consisting of many thousands of small diameter (less than 0.003 in.) glass fibers can be either solid blocks or flexible light tubes. Radio Corporation of America, with the cooperation of American Optical Company, has developed a variety of configurations of fiber optics bundles to demonstrate the importance and the versatility of this new tool in electronics. The most challenging, and perhaps the most important, use of fiber optics is as an image shape transducer. A brief review of basic principles is given preceding descriptions of various applications of fiber optics in electrooptical systems.

THE TRANSMISSION of light from one place in space to another by transparent rods of glass, quartz and plastics is a familiar phenomenon. Similarly, the ability of small, flexible filaments of quartz to conduct light is well known. The possibility of transmitting images by bundling together in a systematic manner a large number of such filaments (or fibers) was suggested at least 30 years ago.[1,2,3] More recently this concept was revived and given new impetus by Van Heel in the Netherlands[4] and Hopkins and Kapany in England.[5] Subsequent work in this field has resulted in a new technology which is now generally called *fiber optics*.

Basic Principles

Light entering the end of a cylindrical rod of a transparent dielectric material, such as glass, will generally be "trapped" by total internal reflection within the rod, and will be conducted by repeated reflections to the opposite end where most of it will emerge. Except for an increase in the number of reflections per unit length, this phenomenon occurs even when the diameter of the rod is made very small (e.g., a fiber). Because of the large number of reflections involved (several thousand in a typical case) it is important that such a fiber have a very good surface, free from irregularities and contamination. Moreover, if the fiber is very long (several feet), absorption of light by the medium becomes important and only carefully selected materials can be used.

Although it is possible to produce fibers (e.g. by drawing from glass or quartz) with the requisite transparency and surface quality, there are two reasons why such fibers are unsuitable for use in most fiber optics applications.

(1) Contamination and/or abuse of the surface gradually decreases the transmission efficiency of the fiber; and

(2) Wherever such fibers contact or even closely approach one another, leakage of light occurs which reduces image contrast.

By surrounding the fiber with a thin "jacket" of a transparent material having a lower index of refraction than the fiber "core" both these limitations can be avoided.[6,7] This jacket serves both to separate the fibers and to protect the surface at which the internal reflections take place. Properly "jacketed" or "clad" fibers may be gathered together without regard to contamination or leakage. Figure 1 shows a bundle of such fibers gathered and cemented together in a short sleeve at one end and fanned out at the other. Except for a

Fig. 1. Bundles of clad fibers gathered and cemented together in short sleeve at one end and fanned out at the other.

Presented on May 2, 1960, at the Society's Convention in Los Angeles by L. J. Krolak (who read the paper), Defense Electronic Products, Radio Corp. of America, Camden 2, N.J.; W. P. Siegmund, American Optical Co., Southbridge, Mass.; and R. G. Neuhauser, Tube Division, Radio Corp. of America, Lancaster, Pa.
(This paper was first received on July 21, 1960, and in final form on August 8, 1960.)

few broken fibers, virtually no light is seen to leave the bundle except at spread-out ends of the fibers.

The ability of a glass fiber to "trap" a ray of light by total internal reflection and to transmit that ray is a function of the indices of refraction of the fiber and its surrounding medium. A schematic diagram of a ray passing down a jacketed fiber is shown in Fig. 2. The angle (i) which the entering ray makes with the axis defines the numerical aperture of that ray, and the largest angle for which the meridional ray is trapped by such a fiber is given by:

$$\sin i = \sqrt{n_g^2 - n_c^2}$$

where n_g is the index of refraction of the fiber "core" and n_c is the index of refraction of the jacket or cladding. Since the entering ray is assumed to be in air, this represents the maximum numerical aperture of the meridional ray which the fiber will transmit and might be termed the "nominal" numerical aperture. A typical combination of refractive indices for fibers used in applications requiring a high numerical aperture is $n_g = 1.75$ and $n_c = 1.52$. This gives a nominal numerical aperture of 0.86, or an equivalent lens speed of $f/0.58$. Skew rays which follow helical paths down the fiber can be transmitted at still higher numerical aperture and are important in the transmission efficiency of fibers with practically perfect cross-section geometry, such as those used in flexible bundles. Fused-type fibers do not have this highly regular geometry and so do not benefit from this skew ray behavior.

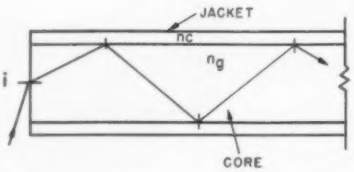


Fig. 2. Ray passing down clad fiber where n_g and n_c are the indices of refraction of the cladding and core, respectively.

Applications

During the last several years, Radio Corporation of America, with the cooperation of American Optical Company, has made much progress toward a better understanding of how fiber optics can be best combined with other electrooptical principles to increase the performance and to decrease the complexity of present image-handling systems. Fiber optics is a unique optical tool. In the form of a flexible bundle, it replaces elaborate lens and mirror systems for transmitting an image between two points that cannot be connected with a straight line. As a solid bundle, fiber optics has a much higher photometric efficiency than a conventional lens system for high-speed printout systems, as will be illustrated later. Perhaps the most unusual capability of fiber optics is that of changing the shape of the image. Since each fiber transmits an element of the light image, the fibers at the output end of the bundle can be reoriented with respect to the input end so as to create special patterns of an image. Flexible bundles, efficient solid bundles, and shaper transducers are the basic fiber optics building blocks for either improving present electro-optical systems or creating new ones not possible before. Various applications of fiber optics that have been demonstrated are described below.

Fiberscope

Probably the most distinctive form of fiber optics is the flexible telescope[3] or "fiberscope" (Fig. 3). The principal component is a bundle of fibers identically arranged and cemented at both ends but loose and flexible in between. An image formed at one end of the bundle by an objective lens is broken into as many elements as there are fibers and transmitted, element by element, to the other end where it is viewed through an eyepiece. The image quality is completely independent of the flexure of the bundle unless carried to the point where fibers are broken, a situation which can be avoided by enclosing the fibers in an appropriate protective sheath.

The flexible fiber optics bundle has a rectangular cross section of about 8 by 10 mm and contains approximately 32,000 fibers, each 0.002 in. (50 microns) in diameter and 36 in. long. It is fitted with a standard 1-in. focal length motion-picture camera lens (C-mount) and an 8 × eyepiece. The sheath, a flexible, stainless-steel, convoluted tube in a braided envelope, is virtually crush-proof and has a constrained flexibility to protect the fibers from accidental breakage.

Photographs may be made through this system either by relaying the image at the exit face of the fiber bundle onto the film with an auxiliary lens or by placing the end of the fiber bundle directly against the film. A photograph made through the "fiberscope" by the first method is shown in Fig. 4.

Fiber Optics Faceplate

Solid fiber optic bundles, when inserted in or used as faceplates, can improve the optical efficiency when recording from either a high-speed cathode-ray tube or a character-display tube.

In both tubes the image is formed by the electron beam impinging on the phosphor layer on the inner surface of the tube face. Because of the thickness of this glass face, a lens must be used to record or transmit a clear image of the phosphor image to a film or other light-sensitive surface. For many purposes this approach has been entirely adequate although wasteful of light. For recording from either the high-speed cathode-ray tube or the character-display tube, even a relatively fast lens seriously limits the

Fig. 3. Flexible "fiberscope" with objective lens at one end and eyepiece at the other.

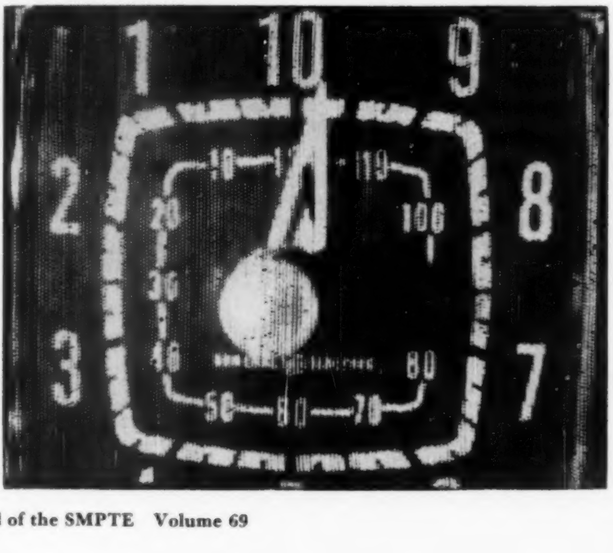


Fig. 4. Photograph of clock face made through flexible "fiberscope."

efficiency of the system. Special high-speed lenses have been built for this purpose, but they are generally very bulky and expensive.

Such lenses can be replaced by a more efficient special tube face consisting of a large number of clad, closely packed, parallel fibers fused together into a solid mass. The resulting fused faceplate is vacuum-tight and being of all glass construction, it will withstand the bake-out cycles used in vacuum tube fabrication, provided the expansion coefficients of the various glasses match. As in the flexible "fiberscope," each fiber in the tube face transmits an element of the image from one end to the other, in this case from the phosphor on the inside of the tube to the outside surface of the tube. A film placed in contact with this outer surface will record a clear image from the phosphor. If the difference in index of refraction of the fiber "core" and its surrounding jacket is sufficiently large, the optical efficiency will be higher than with any ordinary lens, or even with the "specials." The resolving power of such a tube face is again limited by the size and number of fibers it contains. Fibers of a thousandth of an inch or less in diameter are used, and tube faces of various sizes and shapes have been built.

To demonstrate the optical efficiency of such a tube face relative to a conventional lens for recording from a cathode-ray tube, an experimental tube was made up with a small (1-in. diameter) tube face (Fig. 5). Except for the tube face, it was a conventional electrostatic deflection type of cathode-ray tube.

The tube face contained approximately 100,000 fibers of 0.003-in. diameter. The nominal aperture based on the indices of refraction of the glasses used is equal to 0.86 or in terms of lens speed an f/number of 0.58. To determine the effective speed a set of photographs was made, first by the use of a conventional f/2.0, 58mm focal length camera lens at unit magnification (Fig. 5A); then

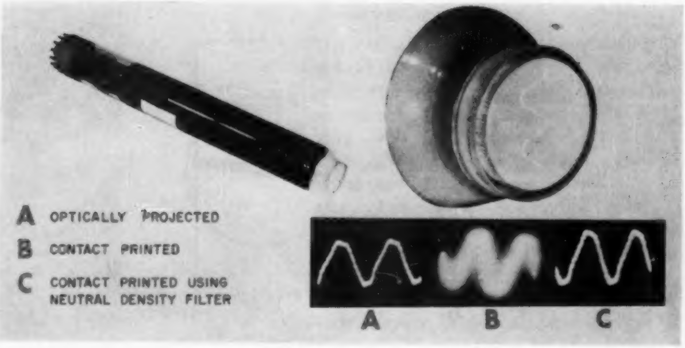


Fig. 5. Experimental cathode-ray tube with fiber optics faceplate.

by direct contact printing against the tube face (Fig. 5B); and then by printing through a compensating neutral-density filter placed between the tube face and the film (Fig. 5C). In each case the film, exposure time, processing and trace intensity were the same. The photograph for Fig. 5B was grossly overexposed due to the higher optical efficiency of contact printing through the fiber optics tube face. Figure 5C was made with a 1.70 neutral-density filter between the film and the tube face (a 50:1 reduction in exposure). Allowing for the fact that the fiber optics tube face was also used with the first exposure (through the conventional lens) the gain in optical efficiency is still at least 40 times over the f/2.0 lens. The T-stop of the lens was measured to be 2.22 and at unit magnification this becomes T-4.44, therefore, the tube face has an effective speed of $4.44/\sqrt{40} = \mathrm{T}-0.70$.

Airborne Television

The fiberscope when used in combination with a specially developed vidicon tube can effect a substantial savings in some airborne television systems.

At present, expensive and cumbersome gimballing equipment is used to stabilize the camera against the unavoidable movements of the airplane. A fiber optics flexible bundle with a lens at one end and with the other end connected to a TV camera containing a vidicon picture tube with a fiber optics faceplate eliminates the need to stabilize the camera unit. Only the end of the fiber optics bundle with the objective lens must be stabilized.

A working model of such a camera (Fig. 6) includes a flexible bundle butted against a fiber optics faceplate on the vidicon tube (Fig. 7).

The development of a vidicon tube having a fiber optics faceplate was relatively straightforward. The assembly techniques for the RCA 7038 vidicon were used. The faceplate sealing technique for this tube is such that quartz, hard glass, soft glass or certain glassy ceramics can be sealed to the bulb with little regard to the expansion mismatch between the faceplate material and the bulb. Also, since the sealing technique is a relatively cold technique and the faceplate glass is not melted in the process, there is no danger of distortion or damage to the fiber bundle.

The faceplate was designed to have a $\frac{5}{8}$-in. diameter bundle of fibers centered in a faceplate of glass made from the same glass as that used in the fibers. The faceplate was made 50% thicker than that of a conventional vidicon tube

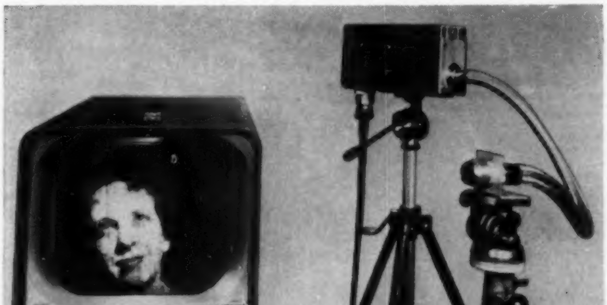


Fig. 6. Working model of airborne stabilized TV system. Special vidicon tube is constructed with fiber optics faceplate and flexible fiberscope.

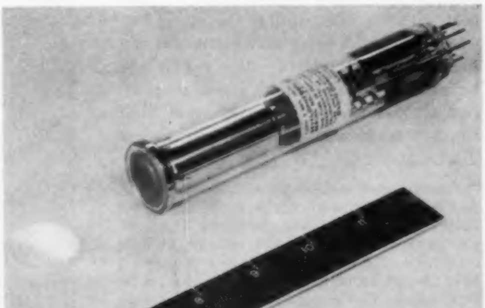


Fig. 7. Vidicon picture tube with fiber optics faceplate. Fibers have diameter of 0.0006 in.

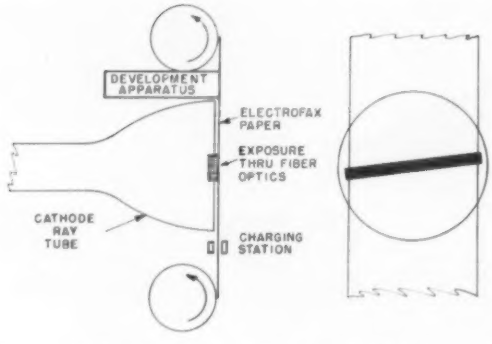


Fig. 8. Illustration of use of fiber optics for high-speed printing application using a compositron tube.

to assure adequate strength. The biggest problem in the fabrication of this tube was the development of a transparent conductive coating technique which would produce a clear coating on this high-lead glass without damaging the glass or the fiber structure.

The first tube made with this technique had a fiber bundle made from 0.003-in. glass fibers. Resolution of this tube was limited to about 120 TV lines by the fiber structure. Subsequent tubes made with 0.0006-in. fibers had a resolving capability of about 600 TV lines which was close to the resolving capabilities of the tube itself.

High-Speed Printing

A high-speed non-impact electronic printer is now being built for use with computer systems. Ordinarily, displayed characters are recorded on various types of photosensitive materials by means of a lens system from either a character display tube or a cathode ray tube which is backed up by the appropriate character generating electronics. The photometric efficiency, and thus the printing speed, of such a system can be improved many fold by the use of fiber optics sealed into the face plate of the display device. This type of printer would use photosensitive material directly in contact with the fiber optics.

RCA is building a feasibility model of a fiber optics cathode ray tube which will be used with Electrofax* paper to print out alpha-numeric information at high rates. A schematic drawing of the system appears in Fig. 8. The operation of the tube will be as follows: characters appear at the surface of the phosphor from left to right in sequence looking at the front of the tube. Because of the fiber optics, these same characters also appear at the outer surface next to the paper. The paper moves by the outer surface continuously. Preliminary photometric tests with this type of tube and Electrofax paper indicate a printing speed of about 20,000 characters/second.

High-Resolution Reconnaissance and Facsimile Pickup

Fiber optics make possible completely nonmechanical, high-resolution aerial reconnaissance. The storage characteristics of image-orthicon tubes gives them very high sensitivity relative to photocell spot scans or photographic film systems. For the image-orthicon tube, the effective exposure time per picture element is the reciprocal of the frame rate; whereas for a photocell scan system the exposure time is the reciprocal of the element rate. Relative to high-resolution film with an ASA rating of 10—20, the image orthicon is rated at ASA-4000 and higher.

Up until now it has been impossible to utilize the full information capacity of such tubes in photographing at high resolution over wide angles of view. For example, in a conventional TV system an optical system images an entire scene on the photocathode surface of the image orthicon tube. The best limiting resolution that one can expect in this case would be about 500 TV lines or 250 photographic lines per scan line. If it were possible to extend the length of this scan line by some means, the resolution capability of the picture tube would be greatly increased. Figure 9 illustrates how fiber optics is used as a shape transducer to divide a single long scanning line into many TV scanning lines on the photocathode. This effectively lengthens the scan line for the image orthicon. This scanning line may, for example, make 40 line scans of the camera, yielding some 20,000 scanning elements in the reassembled line (500 elements × 40 line scans). A similar fiber optics transducer attached to the fiber optics faceplate of a cathode-ray tube would reassemble the elements into a single image for hard copy printout on a photosensitive medium such as Electrofax paper. By the use of active erase techniques on image orthicons, the frame rate can be raised above the normal 30 frames/sec.

Other features which make this system attractive include:

(1) no mechanical shuttering and film transport mechansim;

(2) no film development and scanning and/or recovery techniques required;

(3) no limitations as a result of storage of non-reusable recording media;

(4) transmission in real time; and

(5) simplified stabilization techniques through the use of fiber optics transducer.

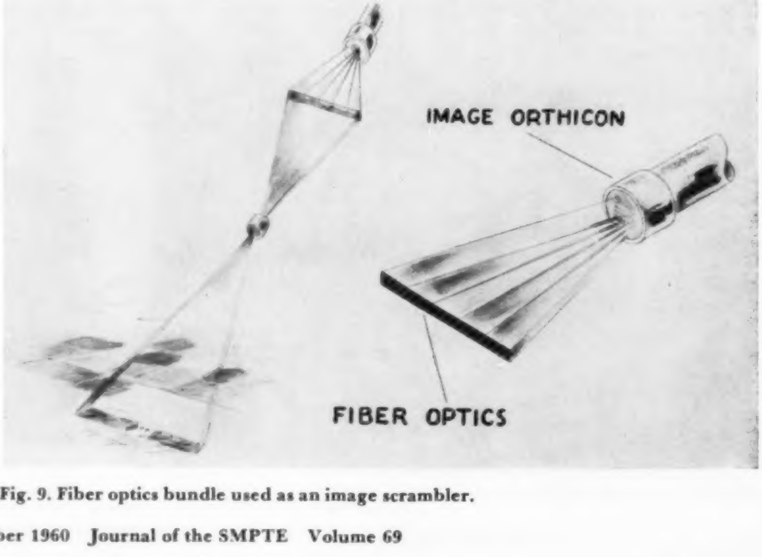


Fig. 9. Fiber optics bundle used as an image scrambler.

* Paper coated with a photoconductor, ZnO. A blanket negative charge is deposited on the ZnO surface by a corona discharge. The ZnO surface is an insulator under certain safe-light conditions. The charged surface is exposed to a light pattern corresponding to the image to be reproduced. The electrical charge flows away from the photoconductive surface in proportion to the light incident upon a given unit area, thus leaving a latent electrostatic charge image. The image is developed by depositing a positively charged thermoplastic resin powder on the ZnO surface. The particles cling in the proper proportion to the electrostatic image. The image is then fixed by heating.

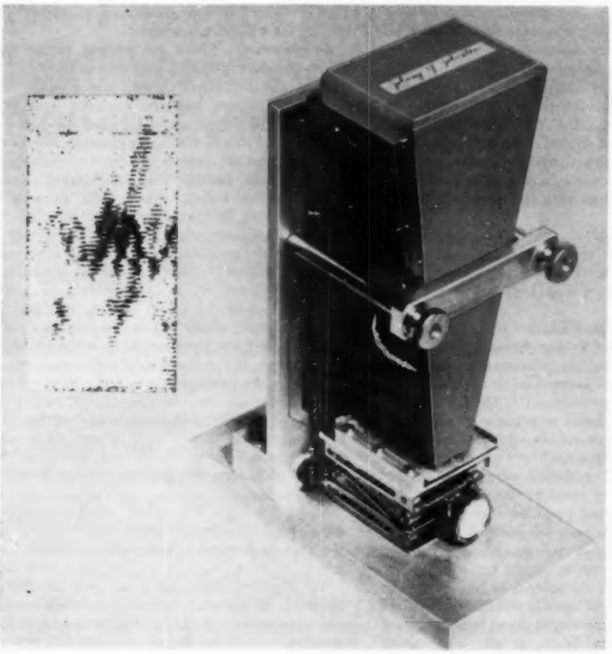


Fig. 10. High resolution fiber optics television utilizing fiber optics as a shape transducer.

This fiber optics TV system can be also used with a high-resolution, high-speed facsimile system. For instance, in transmitting a 20-in.-wide detailed mechanical drawing using a flying-spot scanner with a 3-in.-long scanning line, the smallest element size that could be resolved would be about 0.020 in. in diameter. On the other hand, if a fiber optics transducer bundle with 20,000 fibers of 0.001-in. diameter were used, one could expect an element size at least 0.002 in. in diameter.

Coding Signatures in Bank Pass Books

A fiber optics encoder offers a simple, inexpensive method for coding and inscribing a depositor's signature on a bank pass book. With a fiber optics decoder at each teller window, a bank teller can quickly verify the withdrawer's signature.

The fiber optics encoder is a loose bundle of glass fibers, each fiber being of diameter small enough not to degrade the signature appreciably (for example, 0.002 in.). The input and output faces of the bundle are flat, so that a flat image of the signature card may be focused on the input face for exposure purposes. In between the input and output faces the fibers are scrambled, either by rearranging each individual fiber or by rearranging small groups of fibers. Many variations of the encoding are possible. For example, the fibers may even be rearranged so that all are in a single line which can be placed along the peripheral margin of a page or the cover of the pass book. A simple way to scramble a signature would be to rearrange a small number of discrete vertical blocks of fibers. A signature and its encoding by this technique are shown in Fig. 10.

This signature coding system is extremely attractive because it eliminates signature files at each teller's location and requires only a cheap device to give immediate decoding; and the Electrofax process allows the scrambled signature to be put on the pass book in a very short time.

Punched Card Readout

In simple but advanced computers it would be advantageous for both the computer and auxiliary card reading machinery to read punched cards while they are being transported in a direction transverse to the card length but to obtain information sequentially (i.e., read one column first, then second column, etc.) If ordinary optical or mechanical pickups were used the bits of characters would be read in parallel and, therefore, storage would be required to allow the characters to be read sequentially into a computer.

However, using a fiber optics bundle in the manner described below makes it possible to read out the bits of characters sequentially. A fiber optics bundle is placed behind each hole location (Fig. 11 (a) and (b)). A single light source illuminates the fiber bundles when a hole appears in front of the fiber. The fiber bundles are rearranged into a circular format (Fig. 11(c)). The bits of a given character are adjacent to each other and in sequence. When the circumference of the circle of fibers is scanned with a mechanical disc (Fig. 11(d)), the bits of characters are read out in sequence. The mechanical disc rotates one revolution in the time that it takes the card to travel one card width. This is a fairly slow bit rate (about 10 kc) and places no burden on the single phototube pickup located behind the scanning disc.

The chief advantage of this system is the savings in circuitry over the conventional method of punched card readout. In addition to this, there is a speed advantage and a conservation of bandwidth over present systems. Finally, fiber optics makes it possible to use the card readout in in-line operations (e.g., information read from cards can be fed directly into a computer).

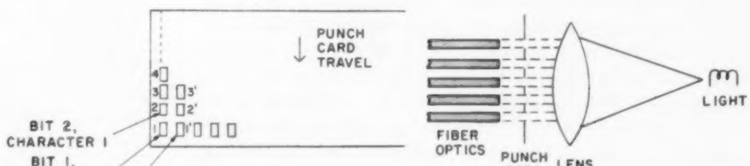


Fig. 11. Punch card readout with use of fiber optics shape transducer.

Future

The successful development of techniques for manufacturing fiber optics bundles and for adapting these bundles to electrooptical devices paves the way for substantial improvement in many systems and for creation of systems heretofore impossible. System improvements will include greater reliability at a lower cost, higher resolution and greater photometric efficiency.

Only a few uses of the new fiber optics building blocks have been described. Each case demonstrates one or more areas of improvement afforded by fiber optics. The greatest challenge to electrooptical systems designers perhaps lies in the broad field of image or form transducers. The shape of the image can now be manipulated by simply rearranging the fibers to create unique signal processing systems that formerly required very sophisticated electronic circuits or that were not at all possible.

References

1. J. L. Baird, British Patent Specification No. 20,969/27, 1927.
2. H. Lamm, *Z. Fur. Inst. K., 50:* 579, 1930.
3. C. W. Hansell, U. S. Patent 1,751,584, 1930.
4. A. C. S. Van Heel, *Nature, 173:* 39, 1954 (letter).
5. H. H. Hopkins and N. S. Kapany, *Nature 173:* 39, 1954 (letter).
6. A. C. S. Van Heel, *De Ingenieur, 24:* 26, 1953 (in Dutch).
7. B. O'Brien, U. S. Patent 2,825,260, March 4, 1958.

Discussion

John Stott (Eastman Kodak Co.): In reference to the use of fiber optics by banks for scrambled signatures, what, exactly, is the method used?

Mr. Krolak: The customer, opening a new account, places his signature on a card. The card is put into a camera which projects the signature onto the entrance end of the fiber-optics scrambler, proceeds down the bundle, gets scrambled in between, and comes out the other face where there is a photo-sensitive medium. The scrambled picture of the signature becomes a part of the bankbook. When funds are withdrawn the withdrawal slip is signed and the teller immediately puts the coded signature into a decoder which he has at his window. He then compares the name on the decoder with the name on the book. Also, the bankbook may contain other pertinent information about the customer.

Mr. Scott: In other words, the teller does have to make a comparison with the decoded signal?

Mr. Krolak: Yes.

A. D. Bates (I.B.M., San Jose, California): The smallest fiber size you mentioned is 0.6 mil; have you done any work with anything smaller or have you run into any diffraction problems?

Dr. Siegmund: Fibers smaller than the 0.6 mil have not been used in any image tube so far. As far as the diffraction phenomena associated with small fibers are concerned, it is known that as the fiber size becomes small compared with the wavelength of light, a series of phenomena occur very similar to the waveguide phenomena encountered with microwave waveguides. The American Optical Company is currently studying these phenomena in considerable detail. Insofar as scatter is concerned, provided that the amount of optical insulation between fibers is sufficiently thick, the order of a micron being generally sufficient, there is no crosstalk between fibers. Of course, even as the fiber core size gets very small the amount of optical insulation still has to remain approximately a fixed amount, and therefore the cores begin to get very small compared to the amount of insulation between them, and the overall system becomes considerably less efficient. For this reason fibers to the order of perhaps 2 to 3 microns are the smallest practical size.

Alan Gundelfinger (Technicolor Corporation): On the cable that you have shown us tonight, is there anything surrounding the fibers other than the coating that you mentioned?

Mr. Krolak: No, there is not. Except at the ends, the fibers are loose and encased in a rubber tube first and then put into the protective sheathing.

Mr. Gundelfinger: Is it possible to enlarge or to reduce the image size from one end of the bundle to the other?

Mr. Krolak: Yes, it is. It is my impression that the American Optical Co. has made small fused bundles which give magnification as high as 16 to 20.

Ken Kaylor (Fairchild Cameras & Instrument Corp.): What is the minimum diameter (or radius) for a fiber optics cable?

Dr. Siegmund: There are several things that affect the answer to that question—first of all the size of the individual fiber, and second, the number of fibers bundled together and how tightly those fibers are combined in the enclosure. Individual fibers, for instance the 2-mil fibers such as are used in this cable—can be bent to about $\frac{1}{4}$-in. radius. The whole cable cannot be bent to that radius because the fibers tend to interfere with one another when bundled together. This particular system, which uses a metal sheath, provides for only about a six-inch radius. But if we remove the metallic sheath and have the fibers confined only in the rubber tube which is inside the metal sheath, this can be wound around about a 1-in. radius, or even a $\frac{1}{2}$-in. radius before there would be serious binding of the fibers. If the fibers have sufficient room to spread out, for example if they were all in a single row, then they can be bent in a very tight radius indeed, perhaps as little as $\frac{1}{4}$ of an inch. Because of the interference of one fiber with another in a bundle of this sort, however, it is best to constrain the bending to the order of several inches.

Anon: At high F number cones of light, is there leakage through these fibers when you bend them through a sufficient radius of curvature?

Dr. Siegmund: Leakage can, at least theoretically, occur as the bending radius is made smaller and smaller, but I doubt that this is a serious practical problem. Before any serious amount of leakage would occur I believe the fibers would break, at least they would interfere with each other to the point where they would begin to break in a practical bundle which would be considered beyond a practical limitation. The leakage of light from that point of view is not a serious matter. Light leakage is serious from another point of view. If your input cone of light exceeds the critical acceptance angle, that is, the numerical aperture of the bundle then light leakage can occur unless each fiber is isolated with an opaque coating. This is more of a problem in the fused-type bundles than it is in the flexible-type bundles because many of the applications for the flexible bundles utilize lenses for input which would generally be slower, that is, lower in effective optical speed than the fibers themselves. In the fused-type assemblies it is possible to have inputs which exceed the maximum numerical aperture which the fibers can transmit and in that case leakage is a problem.

High-Speed Photography Applied to High-Speed Aerodynamic Research at the National Physical Laboratory

By R. J. NORTH

An account is given of the spark light source systems used in the Aerodynamics Division, National Physical Laboratory, for the photography of high-speed flows in wind tunnels and shock tubes. The systems consist of basic units which can be used in various ways, singly or in multiple units as in a Cranz-Schardin system. Some results obtained with such spark light source systems are shown and briefly discussed. These include photographs taken on wind tunnels, shock tubes and shock tunnels with schlieren, color-schlieren and schlieren-interferometer systems.

In the Aerodynamics Division of the National Physical Laboratory, the methods of flow visualization and high-speed photography have been applied to the study of high-speed aerodynamics in wind tunnels and shock tubes over a period of many years. Some of the results have been shown at previous photographic congresses[1,2] and general accounts of the methods used have been published.[3] On this occasion I shall explain some recent developments at the laboratory, show a few results and say why they are interesting to aerodynamicists.

Spark Light Source Systems

Spark light sources of short duration used with schlieren and interferometer systems have been applied to the photography of high-speed airflow in many laboratories since the end of World War II. The properties of these sources which make them useful in this work are their small size, extreme brightness, short duration and relative simplicity. The small size meets the requirements of the optical systems used, the short duration enables the fast-moving details of the flow to be frozen, and the high brightness provides sufficient intensity of illumination for photography despite the small size. At NPL rather simple devices have been used in the past and have yielded fairly good results. Naturally, these were not perfect instruments but their shortcomings were generally accepted with tolerance since experience had shown that all such sources were temperamental. Also there was the feeling that if these devices were made more complicated, the reliability was likely to decrease. However, the necessity to cater for shock tubes demanded some change from the earlier types of untriggered source and it was decided to try to make a spark-light source system which would be suitable for use on the eight wind tunnels, six shock tubes and miscellaneous laboratory experiments in the Division.

Even if the light source itself could not be entirely standardized, there seemed to be no reason why the power supplies, trigger system and delay generator should not be so. In fact, these components presented no difficulty. The light sources were the real problem, bearing in mind that a better standard of performance than previously available was required in a unit which, if it was to be electronically triggered and otherwise more complicated than its predecessors, must give almost no trouble in use because, in general, the aerodynamicists using it could not be expected to be able to rectify faults themselves.

The requirements for this ideal source for schlieren, shadowgraph and interferometer use were summarized as follows:

(a) short duration, about $\frac{1}{4}$ μsec,
(b) adequate intensity for photography,
(c) choice of point source or linear source,
(d) easily changed linear source orientation,
(e) stability of position from shot to shot,
(f) minimum delay and variability in triggering,
(g) auxiliary tungsten-filament lamp for setting-up,
(h) reliability with very little maintenance,
(i) remote control facility, and
(j) inherent safety.

All these requirements are obvious except perhaps (c) and (d). The point source is required for shadowgraph work and is also useful in conjunction with graded filters[3] for schlieren work. The linear sources are required for schlieren systems and interferometers in which large sources can be used: in general the linear sources have greater intensity than the point sources. These requirements were not all met in any of the devices used previously, nor in any known design.

The first apparatus[4] made (Fig. 1) was based on a spark light source design which had been previously used with some success[1,2] comprising a constricted point source of $\frac{1}{16}$-inch diameter in series with an open linear gap (Fig. 2a). With a conveniently small commercially available capacitor (0.01 μf), this made a compact unit which could be mounted, together with a tungsten-filament lamp (as an auxiliary source) and a rotatable mirror (to reflect the light from one or the other source into the optical system) on a frame. The frame, which could be rotated about a vertical axis, was mounted on an optical bench saddle. The purpose of the rotation of the frame was to permit the sources, as seen along the optical axis, to be oriented vertically or horizontally, or at any angle in between (Fig. 3). The spark light source assembly could be arranged so that either the end-fire point source or the linear open gap was seen by the optical system.

A small toy electric motor was used to turn the mirror automatically toward the source selected at the remote control box. An optical condenser mount was provided so that the sources could be focused on an external slit of adjustable size, if required.

Presented on October 21, 1960, at the Fifth International Congress on High-Speed Photography by R. J. North, National Physical Laboratory, Teddington, Middlesex, England.

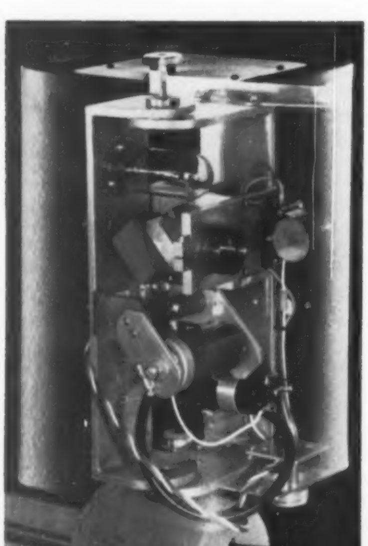
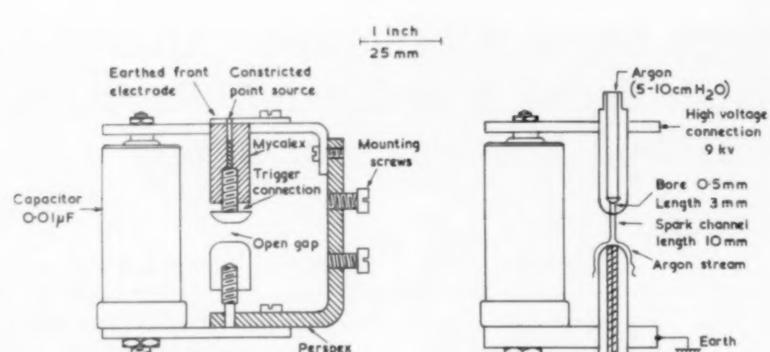


Fig. 1. Spark light source unit with rotatable mirror.

(Cover indicated by double exposure)



(a) CONSTRICTED POINT SOURCE WITH SERIES OPEN GAP

(b) ARGON JET GAP

Fig. 2. Spark light sources.

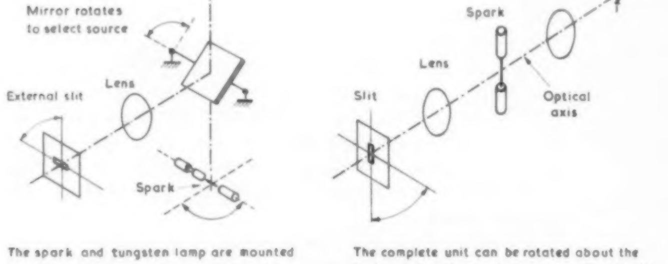
These sources met most of the requirements of wind-tunnel applications, but the stability of the light source position from shot to shot left something to be desired when used in a very sensitive schlieren system. It may be asked why the bore of the constricting tube was not reduced. Experience with bore sizes down to 0.014 in. (0.35 mm), however, showed that this brought undesirable attendant difficulties when used with a schlieren system, such as increased visibility of small surface defects on the mirrors and the windows and the inability to illuminate evenly large angular apertures. This difficulty had been appreciated for some time but it was not until just before the Fourth Congress that the solution appeared, the argon-jet gap due to Thackeray[5] (Fig. 2b). This was referred to at Cologne[2] but since then experience has confirmed that the initial enthusiasm was fully justified. As well as providing a highly stable source, the spark-gap configuration suggested by Thackeray allowed an image of the tungsten-filament lamp to be focused by a condenser on the spark channel position so that a moving mirror could be dispensed with. The spark channel was imaged by a second condenser on to a slit (0.4 by 0.050 in.) or iris on the front panel, thus allowing some choice of the effective source size and shape. The tungsten lamp used is an automobile lamp bulb, because of its compact envelope. The source orientation is changed by rotating the whole unit (Fig. 3).

The same type of capacitor as before was used, and four were fitted to give an increased light output for the interferometer applications. If the minimum duration of light emission is necessary, the number of capacitors may be reduced to one and still leave adequate intensity for schlieren photography.

Photographs of the unit are shown in Figs. 4 and 5.

The triggering of this type of spark gap is extremely consistent and spontaneous firing extremely rare if the gap length is correct for the applied high voltage. The gap length used is 0.4 in. (1 cm) and the voltage is 9 kv. The reduction in voltage from the 12 to 14 kv used with air gaps is due to the lower breakdown voltage of argon. The gap length could have been increased, but 0.4 in. is a suitable value for the source size.

The complete system, including power supplies and trigger circuit and the argon gas supply is illustrated in Fig. 6. The separation of the light source unit and the power supplies was facilitated by the commercial availability of compact coaxial high-voltage plugs and sockets (based on an Atomic Weapons Research Establishment design).



The spark and tungsten lamp are mounted together on a separate frame which can be rotated about a vertical axis to change the effective source orientation

The complete unit can be rotated about the horizontal optical axis to change the effective source orientation.

Fig. 3. Optical systems of spark light source units.

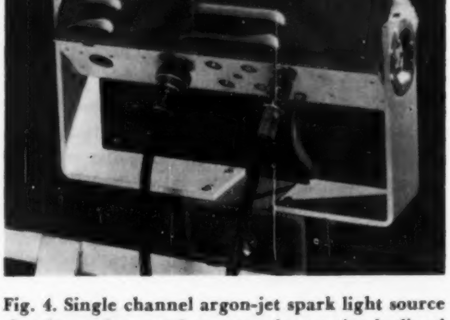


Fig. 4. Single channel argon-jet spark light source showing unit rotated on mounting to give inclined source orientation.

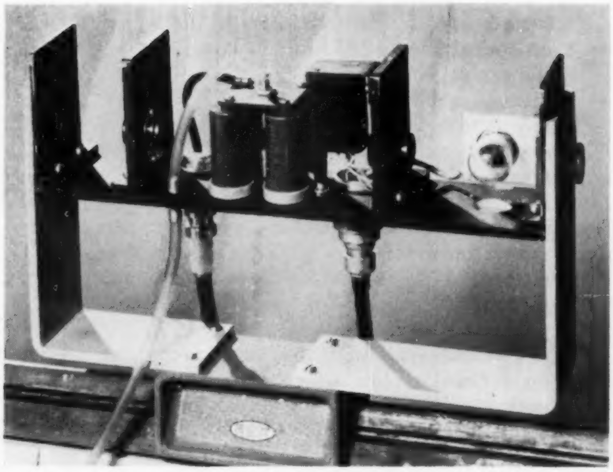


Fig. 5. Single channel argon-jet spark light source with cover removed showing internal layout.

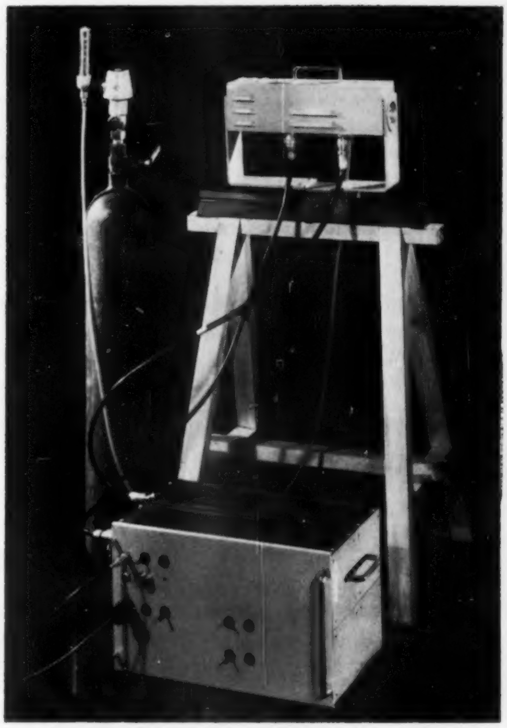


Fig. 6. Argon-jet spark light source unit, complete apparatus.

The circuits are shown in Fig. 7. The trigger transformer is a commercially available type made to an NPL requirement.

When the source is used on a shock tube a delay channel is required: a simple and accurate phantastron delay generator supplied from the main power unit has been used. The circuit is the same as that used in the multiple-spark camera.[2] One section of a delay circuit shown later in this paper could also be used.

The light intensity variation with time for the sources described was shown at Cologne.[2]

Both the light source units described can be used interchangeably with the power supplies. When the argon-jet unit is being used the mirror motor circuit is not required. Complete circuit descriptions are available if required. The present spheres of application of the units described are as follows: the argon-jet units are employed for shock tubes, and the constricted point source units on transonic and supersonic wind tunnels, where the shot-to-shot stability of the latter is acceptable. The units show the same order of reliability and reproducibility of performance as, say, Tektronix oscilloscopes.

Multiple-Spark Cameras

Experience with the earlier (1957) multiple-spark camera[2] (Cranz-Schardin system) showed that the requirements regarded as mandatory for a single source were not reduced when a multiplicity of units was used together. This was especially true when the camera was to be used by those unfamiliar with spark-light sources. Therefore an effort was made to design a multiple-spark camera incorporating the advantages of the argon-jet spark and as easy to use as possible. The single units had been designed to be compact with this idea in mind, and when these were found to be very satisfactory in use, it only remained to design a suitable mounting for a group of them. The attraction of using the same units throughout is obvious. The circuitry also, if not exactly the same in external appearance, was so little different as to remain within the bounds of familiarity.

The original intention was to build a seven-channel instrument, but when the Polaroid-Land 5 by 4-in. film

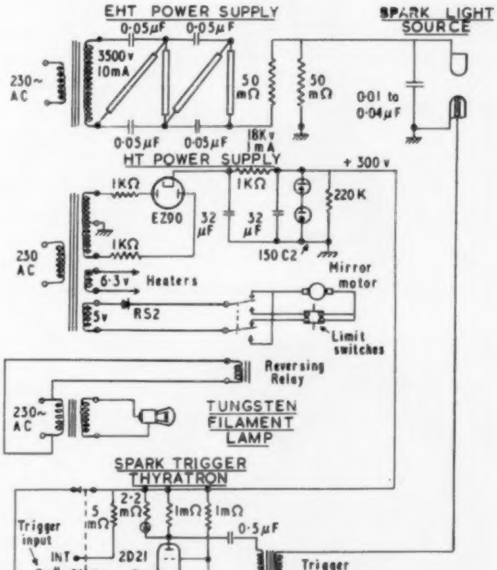


Fig. 7. Spark light source system circuit diagram.

back became available in England it was decided that a more interesting course would be to reduce the number of channels to five, bring the sources closer together to reduce the vignetting[2] by the test section window frames, and accommodate the pictures on the 5 by 4-in. format. This was in line with the intention of making the apparatus easier to use, because the fewer the channels, the easier it is to have them all function correctly every time. The reduction in the number of channels also made individual units of the group of sources somewhat more accessible.

The configuration of the group of sources is shown in Fig. 8. The five units are mounted on five of the six sides of a hollow cubic block. One is mounted on the optical axis which passes through the center of the open sixth side of the block. The other four units are suitably arranged on the sides of the block so that the light from the sources is reflected from plane mirrors, mounted on the front faces of the units, out through the front of the block on optical axes parallel to, but laterally displaced from, the central one (Fig. 9). The light sources are slits of maximum dimensions 0.4 by 0.05 in. (10 by 1.25 mm). It will be noted that, for the effective light sources to be similarly oriented, two of the units are rotated 90° about their own axes. The front of the mounting block is extended to form a bearing so that the five units can be rotated about the central optical axis to allow any required source orientation. The entire unit is mounted on a standard optical bench support: the use of light alloy throughout makes the device less weighty than its appearance suggests.

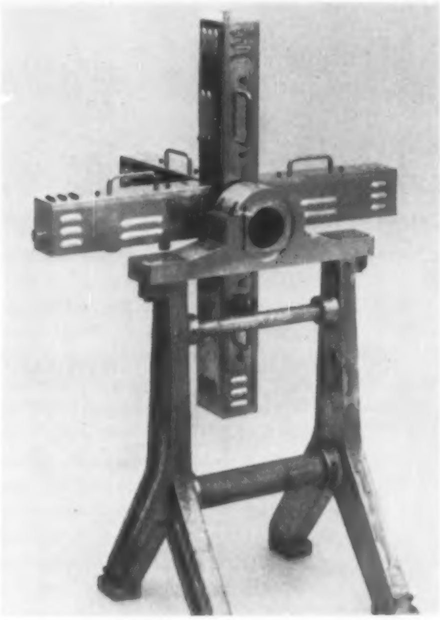


Fig. 8. Light source array of multiple-spark camera.

The schlieren cutoffs and camera lenses are mounted on a circular plate which may be rotated about the optical axis so that it may be aligned with the source array. The schlieren knife-edges were specially designed to provide a sufficient range of adjustment and yet have small overall dimensions so that they could be grouped closely together. The lenses can be changed quickly for others of different focal lengths to obtain different final picture magnifications: this is useful if it is desired to use only one or four channels instead of the normal five. A Polaroid-Land 5 by 4-in. camera back is used on a Kodak adapter back ($\frac{1}{2}$-plate to 5 by 4 in.); a normal Kodak $\frac{1}{2}$-plate back can also be used.

The power supplies are fed to the five units via flexible cables. The circuitry can be exactly the same as that for the earlier camera. The delay channels for that camera were based on the phantastron circuit. As a result of inquiries received from other laboratories concerning the earlier design, it was realized that the fact that the electronic circuits were not commercially available was something of a barrier to the manufacture of the camera by some small research groups. For this reason some other delay systems were tested to see whether appreciably simpler circuits could be made to work with sufficient precision. It should be remarked that delay units are available commercially in the United Kingdom which have more than adequate performance but that they are quite expensive compared with these homemade circuits.

The first of these circuits employs triode amplifiers between the successive 2D21 trigger thyratrons. When the first in the chain fires, a negative pulse from the anode cuts off the triode ($\frac{1}{2}$ of 12AT7). The positive step with a fast rise time from the triode anode is fed to the grid cir-

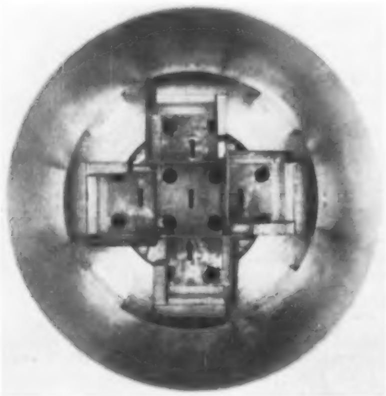


Fig. 9. Light source array of multiple-spark camera (close-up of slits and mirrors).

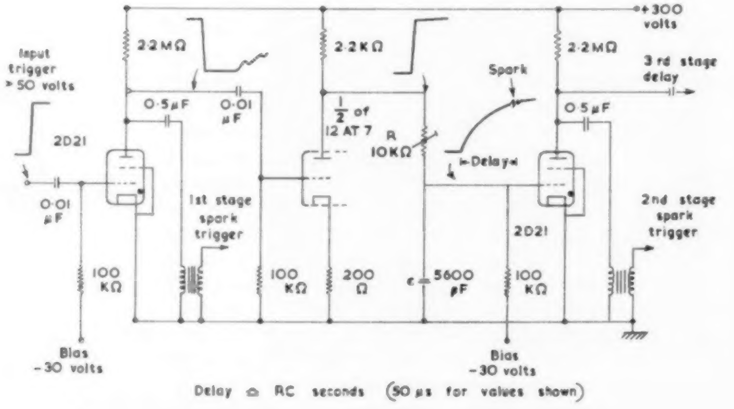


Fig. 10. Delay circuit for multiple spark camera.

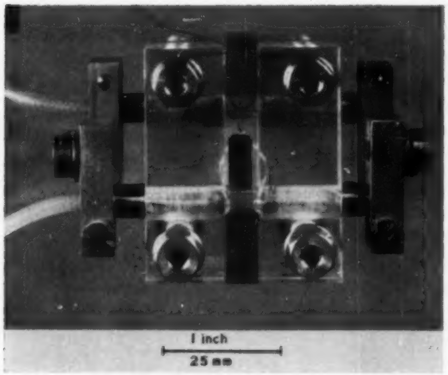


Fig. 11. Spark-operated shutter. View, almost along optical axis, showing normally closed shutter blade in position. The spark connections to the rectangular brass terminals are omitted for clarity. The trigger leads can be seen.

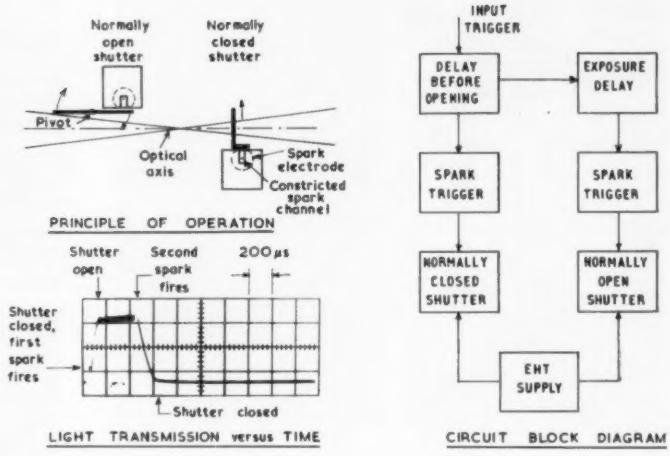


Fig. 12. Spark-operated shutter.

cuit of the next thyratron. A resistance-capacity network in the grid circuit results in the grid voltage rising exponentially instead of in a step. When the grid voltage exceeds the bias level the thyratron fires: this process repeats down the chain. The delay between the firing of successive thyratrons is decided by the circuit values. Apart from the thyratrons, the only electron tubes required are a triode amplifier section for each channel, and as double triodes are the obvious types to use, this means half that number of envelopes. The circuit is shown in Fig. 10. There is nothing novel in this circuit: the essential features will be quite familiar but it should be mentioned because its reliability and reproducibility are surprisingly good. A feature which would be of interest in a situation with sporadic external interference is that the frequency response of the thyratron grid circuit is quite poor so that it is relatively unaffected by stray pulses of short duration.

If short fixed delays between channels are sufficient, passive delay lines are a simple solution and they are now freely available from commercial sources, sometimes in a form in which the delay can be varied by tappings on the line. Delays of 100 μsec are probably the reasonable upper limit of this system.

A second circuit that has been experimented with is one based on the idea of using the horizontal sweep waveform generated by an oscilloscope: this waveform is usually accessible. The oscilloscope sweep is triggered and the ramp waveform is fed into a simple voltage comparator circuit so that as the waveform voltage passes through preset levels a small pulse is generated. These pulses are amplified and used to trigger the thyratrons. The oscilloscope sweep may be used to set up and monitor the proper operation of the camera. The use of a monitor is always advisable because at the first sign of an unexpected result it is usually suggested that there has been a trigger timing error.

A third circuit, which is attractive in principle especially if exactly equal delays are required, works as follows. A ringing oscillator is arranged to start on receipt of a trigger pulse, or preferably a gating waveform: such oscillators are common in radar circuitry. Suitable pulses are produced at the oscillator frequency, or a subharmonic, to notch round a beam switching tube or trochotron. The output pulses from the beam switching tube are amplified and inverted and used to trigger successive channels of the camera. Commercially available trochotrons will operate at rates in excess of 1 mc; the early type used for the experimental circuit ran at 300,000 cps, much faster than was required. The spark capacitors will discharge on the first firing and not recharge for at least $\frac{1}{10}$ sec by which time the oscillator will have been muted. If more than ten channels are required, extra trochotrons can be used.

Spark-Operated Shutter

At this point it seems worth mentioning another device which is electrically the same as the light source but uses, not the light emission of the spark discharge, but the mechanical effect, to operate a shutter.

The shutters available for use in some shock-tube applications have various shortcomings. The well-known mechanical shutters which are commercially available are rather slow to open and close. The electro-optical shutters[3] are very fast but have poor open transmission and finite closed transmission. Blast shutters are not commercially available in the United Kingdom at present. For use with rotating drum and mirror cameras and with spectrographs, various laboratories[7,8,9,10] have developed other electronically operated shutters. The one used at NPL is shown in Figs. 11 and 12. It consists of two parts, one to open, one to close, which are independently controlled. The shutter blades of 0.005-in. Mylar sheet are moved by the direct action of the heated gas from the spark discharges. An advantage of this design is that the shutter is very simply reset by returning the blades to their original positions. The shutter will open and close within 100 μsec of the arrival of the open or close pulse when using capacitors of 0.2 μf at 8000 v. The rate of operation can be improved by increasing the discharge energy, but since the shutter met the immediate requirements, no effort has been made as yet to see just how fast it might go.

The electrical circuits are shown in block diagram form in Fig. 12: the circuit details are as for the light sources.

The shutter is intended for use with a focused beam or near a compact source; the aperture is 0.4 in. (1 cm).

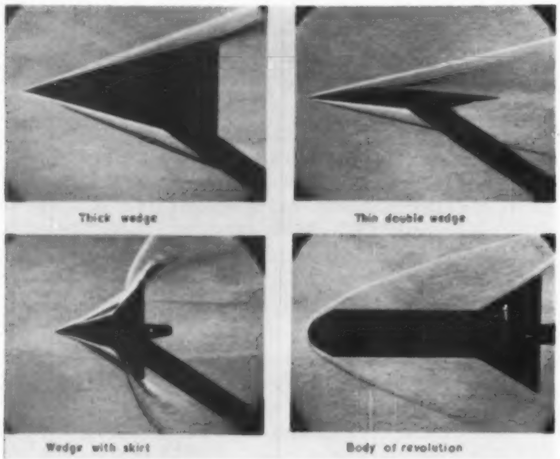


Fig. 13. Schlieren photographs in hypersonic shock tunnel ($M = 6.5$, $T_{stag} = 2300$ K, $P_{stag} = 85$ atm,).

Flow Photographs *at $M = 6.5$, a Stagnation Temperature of 2300 K and a Stagnation Pressure of 85 Atm*

At the last Congress a set of photographs were shown of the flow round a spherical model in a by-pass shock tunnel at NPL as an illustration of what could be done and, incidentally, as an oblique indication of the difficulties in the design and operation of these devices. Since that time the shock tunnel has been converted to reflected-shock operation[6] and it has been used for aerodynamic studies. Some of the initial results are now shown.

The character of the flow around some two-dimensional and three-dimensional bodies is shown in Fig. 13.

The photographs enable the aerodynamicist to gain some insight into hypersonic flow phenomena, and comparisons with more familiar supersonic flows help to indicate the important differences between the regimes.

One feature which is striking in these photographs is the apparent absence of wake and other flow details. The lack of such details is not entirely due to the flow Mach number but is a consequence of the low air density in the working section of the shock tunnel. This is due to the fact that in order to generate high Mach number flows at high working section densities, very large pressures are required in the chamber of the shock tunnel. Further, low densities are required in order to simulate the proper conditions of flight at very high altitudes. The magnitude of the effects observed by flow visualization systems depends on the refractive index variations of the gas in the undisturbed stream in the working section. The refractive index variations decrease with the flow density in accordance with the Gladstone-Dale relation. A flow visualization system of increased sensitivity would be a solution to this difficulty.

The appearance of the boundary layers in these photographs is interesting in that they look rather different in profile from those at lower Mach numbers and higher densities. It is possible that this effect is due to the modification in the density profile brought about by heat transfer from the hot flow to the relatively cold model. These boundary layers are all laminar, which accounts for their smooth nonturbulent appearance.

In the photographs in Fig. 13 the flow was fully established, but all flows take some time to reach a steady state. In ordinary wind tunnels this time is too short to be of any interest, but in a hypersonic shock tunnel with a total operating time of from hundreds of microseconds to tens of milliseconds the time to establish steady flow is of some importance as it may represent an appreciable part of the total duration of flow.

In Figs. 14 and 15 are shown some photographs of the flow along a flat plate (the upper surface of the model) and the flow along a plate and up a step. As can be seen from the times quoted, it takes up to 600 μsec for the flow to become established in its steady state. As a matter of interest, this is about 4 ft (1.2 m) of flow distance or about 10 body lengths.

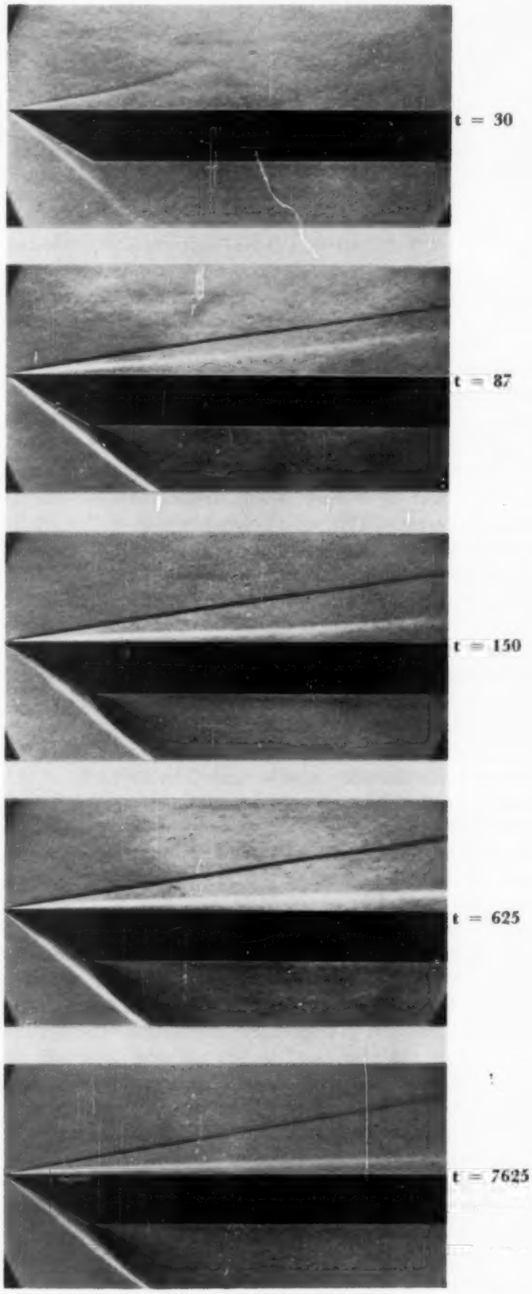


Fig. 14. Schlieren photographs of the flow along a flat plate in a hypersonic shock-tunnel at $M = 6.5$; time (t) in microseconds.

Flow Photographs *of Shock-Wave, Boundary-Layer and Contact-Surface Interaction in a Reflected-Shock Tunnel*

The reflected-shock operation of shock tunnels is now a familiar system. The shock wave generated by the bursting of the diaphragm is allowed to reflect from the end wall of the shock tube and to pass back up the tube. Thus it twice heats and compresses the gas at the end of the tube. This reservoir of hot compressed gas is allowed to expand through a nozzle into the test section where it flows round the model. However, the phenomena upstream of the nozzle largely decide the uniformity and duration of steady flow in the test section. For this reason the conditions in the reservoir have been simulated in a shock tube of rectangular cross section with glass windows so that the flow could be observed.

A series of schlieren photographs are shown in Fig. 16 for a shock Mach number of 6. This is a special condition, known as the tailored* condition, for the driver and driven gases used (hydrogen-air). Under these circumstances the reflected shock passes, without partial reflection, straight through the hydrogen gas originally behind the diaphragm, the front boundary of which is called the contact surface.

A feature of the flow which is interesting is the strong interaction between the reflected shock and the boundary layers on the walls, in which the boundary layers seem to be stopped and swept up by the shock. Also, the contact surface can be seen to be anything but a plane surface, so

* This was first suggested by C. E. Wittliff, M. R. Wilson and A. Hertzberg of the Cornell Aeronautical Laboratory.

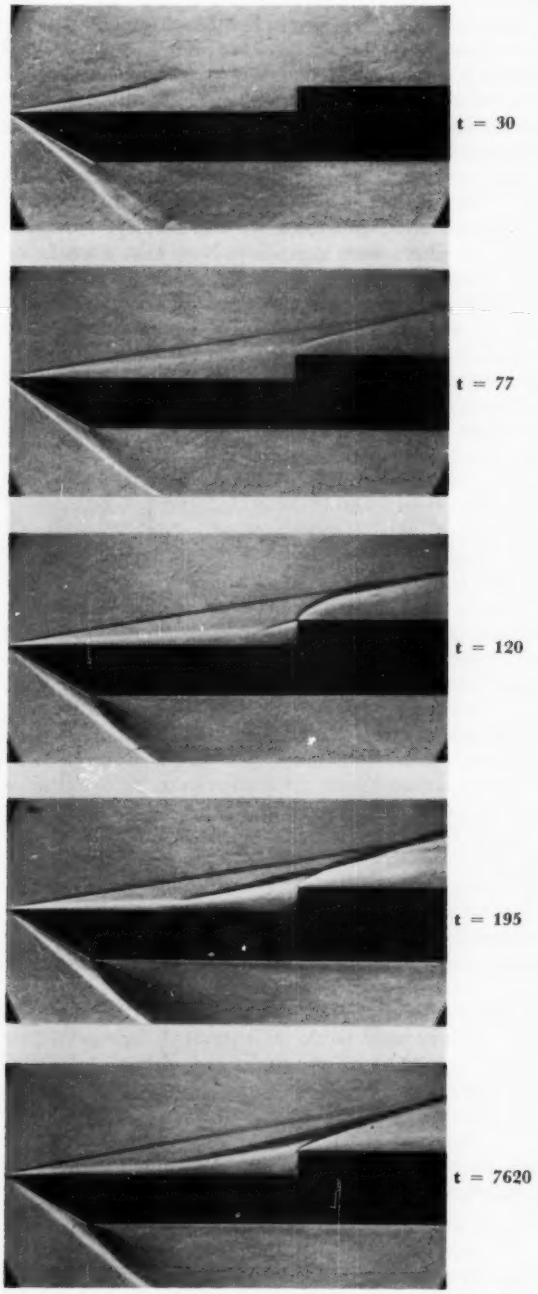


Fig. 15. Schlieren photographs of the flow up a step in a hypersonic shock tunnel at M = 6.5; time (t) in microseconds.

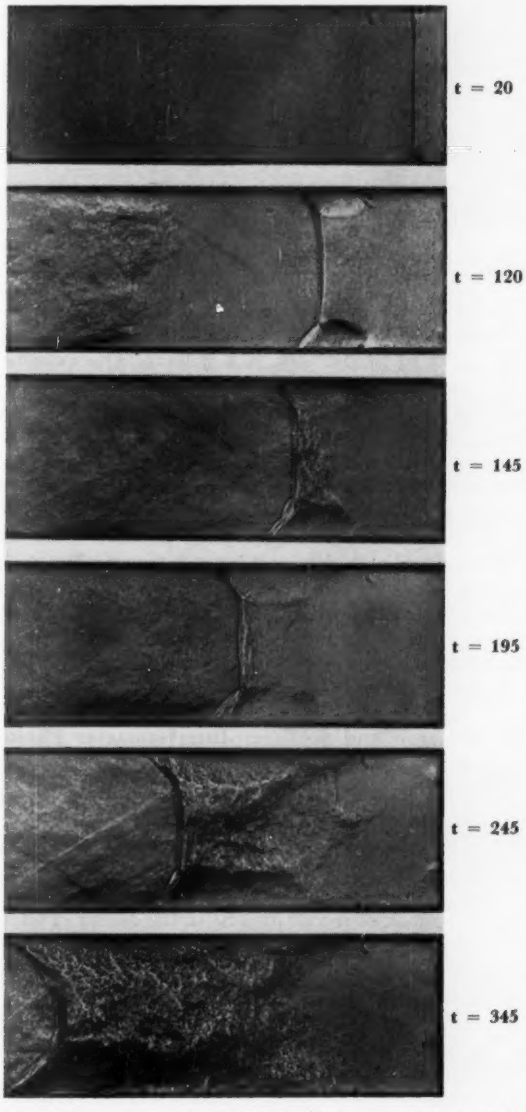


Fig. 16. Interaction of reflected shock, boundary layer and contact surface; shock Mach number 6, hydrogen-air; t = time in microseconds after shock reflection from end of tube.

Fig. 17. Mach-Zehnder Interferometer for use on shock tube.

that interaction between it and the reflected shock will not be quite so predictable as if it were. The extreme turbulence of the gas behind the contact surface, the branching of the shock as it advances into the cold gas and the nonturbulent nature of the shock-heated reservoir of gas next to the end wall of the tube may also be noted.

When this experiment is finished, some studies are to be made in this shock tube of molecular dissociation rates in oxygen and nitrogen using a Mach-Zehnder interferometer[11] with 10 in. diameter plates (Fig. 17). The light source for this work is the argon-jet spark with an interference filter of bandwidth 35 A at half-height, centered at 4505 A, and with a transmission of 73%. Optical tests of this apparatus have been successfully completed.

Color-Schlieren and Schlieren-Interferometer Photographs of Transonic Flows

The foregoing might give the impression that interest has evaporated in all else but shock tubes and hypersonic flow, but in the United Kingdom at least there is at present a much greater commercial interest in the transonic and supersonic speed ranges. In particular, there has been no lack of recent interest in the design of wing sections for the so-called second generation of subsonic jet airliners.

At NPL schlieren and color-schlieren photography[12] has been an invaluable aid to the understanding of the flow phenomena in transonic and supersonic wind tunnels. Any improvements in techniques or new methods have always been examined with interest. In France[13] in recent years a flow-visualization system called the schlieren-interferometer, or polarization-interferometer, has been used, and examples of photographs taken with the system have been shown at previous Congresses by French representatives. It has been suggested that the method has quantitative applications, but it is not that aspect which has been examined at NPL. Instead, the same flows have been photographed with schlieren-interferometer systems of three different sensitivities and corresponding color-schlieren systems in order to determine, if possible, the respective merits of the two methods of flow visualization, used qualitatively. Both methods, in the form used in these tests, respond to the density gradients—that is, the refractive index gradients—in the field of view. A large number of photographs were taken over a range of conditions in the 36 by 14-in. high-speed tunnel. A few are shown in monochrome in Fig. 18, the originals all being in color, of course. The order of colors in the color-schlieren examples is the spectral order from red to blue. The order of colors in the schlieren-interferometer examples is that of Newton's rings, with a black center.

The exposure times were $\frac{1}{4}$ μsec and the argon-jet light source was used. The film was 35mm Agfacolor CT18 reversal material, processed by the factory. No color correction filters were necessary. Now that even faster materials are available, the same results could be obtained with a large format, or shorter exposure time.

In the schlieren-interferometer arrangement the interference occurs between two beams of equal intensity, polarized at right angles and laterally displaced (sheared) from each other by a small distance. This is the reason for the image doubling which is visible in the photographs taken with this system. In the case of flow phenomena near the wing surfaces this is bound to cause some difficulty in interpretation if the optical shear has a component normal to the surface of magnitude comparable with the size of the phenomenon, say, a boundary layer. Another feature of the photographs which is immediately obvious is the fringes. The presence of the fringes makes the picture less simple to interpret than that given by the corresponding conventional schlieren system. This difference is apparent in the examples shown. The range of the color-schlieren system is quoted as the angle subtended by the central green band of the color filter at the second schlieren mirror. The sensitivities of the schlieren-interferometer arrangements are quoted in terms of the shear between beams in the object plane.

Nevertheless, although the multiplicity of fringes might be confusing to the newcomer, those familiar with schlieren photographs of airflow will find in some features of the schlieren-interferometer photographs rather more sensitive indications of some phenomena than they are accustomed to expect. In particular it has been noticed that wakes, boundary layers and regions of separated flow are rather more prominent. How far the images of these features are reliable indications of their actual extent has not yet been fully confirmed. Our study of these aspects is continuing.

An interesting sidelight is that it is possible, on some of the photographs of an aerofoil mounted in slots in glass discs, to see an indication of the strain in the glass on the periphery of the slots. This is due to the stress-optical effect in glass.

The work done so far at NPL with the schlieren-interferometer system has shown that it is a valuable addition to the methods of flow visualization but that it is unlikely to supplant the conventional schlieren systems

when qualitative and not quantitative results are required because of the simpler adjustments and presentation of the better-known methods.

Photographs of the Flow at the Blunt Trailing-Edge of an Aerofoil, With and Without Blowing

Some examples have been given of the use of short exposure times in transonic flow. There are occasions, however, when, if a long exposure time is used, the integration effect of the photographic emulsion gives an indication of the mean geometry of the flow. If the flow in boundary layers, wakes or separations is fluctuating, then it is helpful to the aerodynamicist to be able to observe both aspects of the situation, the mean and the instantaneous. In the case of a turbulent flow separation from a surface, it has been found previously that short exposure time photographs do not convey the shape of the separated region so well as a time exposure. Figure 19 shows a recent example of this point. The photographs show the wake and rear part of an aerofoil in a transonic wind tunnel. The trailing edge of the aerofoil is blunt and normally the flow separates from the edges. The wake is an example of a Karman vortex street with the eddies shed alternately from each edge of the aerofoil base: this can be seen in the spark photograph and the time exposure shows the symmetry of the mean flow.

If air is blown out of the base into the separated flow region, the fluctuations are suppressed for quite small blowing rates, and over a range of blowing rates the aerofoil drag is decreased.[14] The photographs with blowing do not show the same marked apparent differences in flow pattern with exposure time.

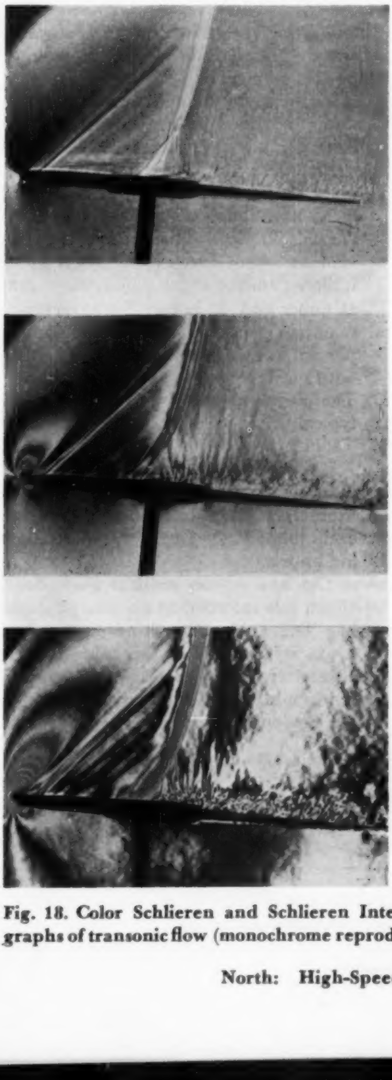
The mean flow patterns are significant because they are relevant to the mean forces on the aerofoil; the instantaneous flow patterns are important because of the insight they provide into the possible unsteady loads associated with the eddying wake. If the flow is steady, the short duration exposure provides both the fine detail and the general pattern.

Acknowledgments

The work described above has been carried out as part of the research program of the National Physical Laboratory, and this work is published by permission of the Director of the Laboratory.

References

1. D. W. Holder and R. J. North, "Schlieren methods for photographing high-speed air flows," Royal Photographic Society Centenary Conference, 1953.
2. R. J. North, "A Cranz-Schardin high-speed camera for use with a hypersonic shock tube," *Proc. 4th International Congress of High-Speed Photography*, Verlag Dr. Othmar Helwich, Darmstadt, Germany, 1959.
3. D. W. Holder, R. J. North and G. P. Wood, "Optical methods for the examination of flow in high-speed wind tunnels," AGARDograph 23, 1956.
4. R. J. North, "A multi purpose spark light source system," NPL/Aero Note 379, 1959.
5. D. P. C. Thackeray, "Preferential ionization of argon in the presence of air and its application to electric discharge devices," *Nature, 180:* 913, 1957.
6. D. W. Holder and D. L. Schultz, "On the use of shock tunnels for research on hypersonic flow," *Proc. 2nd International Congress of the Aeronautical Sciences*, Zurich, 1960.
7. H. E. Edgerton and F. I. Strabala, "Rapid-closing electronically-operated shutter," *Rev. Sci. Instr., 27:* 162, 1956.
8. W. H. Wurster, "High-speed shutter for spectrographs," *Rev. Sci. Instr., 28:* 1093, 1957.
9. D. Bershader, Private communication, Lockheed Aircraft Corp., Sunnyvale, Calif., 1959.
10. J. C. Camm, "High-speed spectrograph shutter," *Rev. Sci. Instr., 31:* 278, 1960.
11. L. Tanner, "The design and use of interferometers in aerodynamics," ARC R. & M. 3131, HMSO, London, 1959.
12. R. J. North and R. F. Cash, "Colour schlieren photography in high-speed wind tunnels," NPL/Aero Note 383, 1959.
13. M. Françon, "Polarization interferometers applied to the study of isotropic objects," *Proc. Symposium on Interferometry, National Physical Laboratory*, Teddington, 1959.
14. D. W. Holder, "The use of blunt trailing edges on transonic wing sections," ARC Report in preparation.



Color Schlieren (range 0.001 radian)

Schlieren Interferometer (shear 1/2mm)

Schlieren Interferometer (shear 2mm)

Fig. 18. Color Schlieren and Schlieren Interferometer photographs of transonic flow (monochrome reproductions).

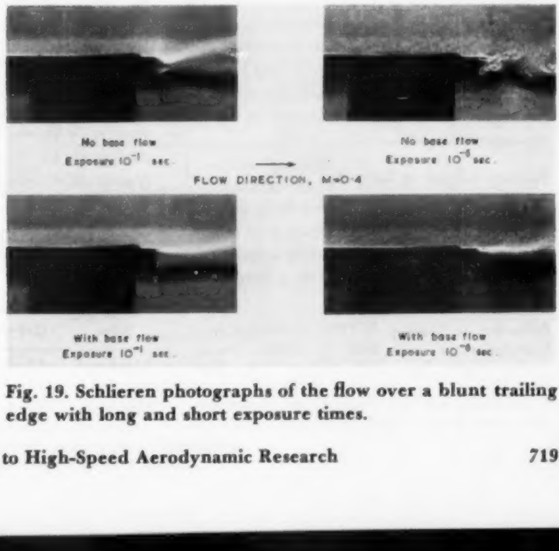


Fig. 19. Schlieren photographs of the flow over a blunt trailing edge with long and short exposure times.

A New System for Post-Synchronous Recording

By DENNIS GUNST

During the recording, the modulations of the actor's voice together with associated control tracks automatically position the new track against the original track, so that the burden of maintaining synchronization is removed from the actor and placed on electronic controls. Experiments have been made illustrating the principles of the method.

Recording a high-quality dialogue track on location, or even on the soundstage, is both complicated and expensive. Even the strict discipline necessary to make certain that dollies move quietly, lamps burn silently and personnel work noiselessly is of little avail if the soundtrack is ruined by a disturbance such as a passing diesel truck or a jet plane. Unfortunately as our civilization becomes noisier, it is increasingly difficult to make good noise-free recordings.

Because it is much slower working under conditions where absolute silence is mandatory, the director will often choose to post-sync a sequence rather than wear everyone out trying to obtain a perfect soundtrack. Although he may decide to post-sync, a synchronized soundtrack will generally be made during the course of the shooting. This will be used later as a guide for the actors when they re-record the dialogue.

Current Post-Sync Systems

The most popular method of recording post-synchronously is that of "looping." Loops of the picture and guide track are projected for the actor as many times as he may require. These loops provide three basic purposes: cuing, rehearsing and feedback.

At the beginning of the loops there is a cue to help the actor start them in synchronization. This cue is generally in the form of a diagonal line across the film, ending on the frame at the point where the actor should start his first word, or it is a series of punched holes that serve to give him a count-down to his first word. The loops rehearse the actor for the correct rhythm and speed. During the recording, the loops act as a prompter or feedback device to keep the actor in sync.

Factors Affecting Looping

In order to study the various factors affecting the rate at which it is possible to record with loops, a simple apparatus was prepared. It consisted of a magnetic disc recorder with two arms. The outer arm, following a circular track, plays back rhythmic beats recorded on the circumference of the disc. The inner arm, following a spiral track, records attempts at keeping in synchronization with the beats. These beats can be heard over earphones or can be viewed on an oscilloscope.

The errors in synchronization are shown by Fig. 1. It can be seen that reducing the pause between beats reduces the errors, and these errors are smaller when the ear rather than the eye receives the stimulus.

The effect of pauses in increasing errors in synchronization is further illustrated on the graph. (Fig. 2.) where errors in synchronization of a well-rehearsed dialogue are shown by the two irregular lines. The line generally on top (which shows the larger errors) represents the first word of every phrase of the dialogue, while the lower line represents a specific mid-syllable of each phrase. The explanation of this is that the large errors in the top line are induced by the pauses between phrases. It is obvious from this graph that the longer the loop, the greater the chance of hitting these gross errors.

The type of dialogue is another very important factor which affects the rate at which it is possible to record with loops. Basically, the simpler the rhythm pattern of the original recording, the easier it is to post-sync. This is borne out by the fact that prescoring is used when making musicals, showing how easy it is to "sing a song in sync." On the other hand, an extemporaneous talk, full of hesitations, "buts" and "ums," proves unusually difficult to post-sync. Between these two extremes — the rhythmic song, and the completely unrehearsed speech — there lies the well-rehearsed dialogue that forms the bulk of the voice tracks on dramatic shows. Although this dialogue does not contain the simple rhythm of a song, an actor will give to his dialogue a logical rhythmic pattern, which will come naturally to him during a later post-sync session.

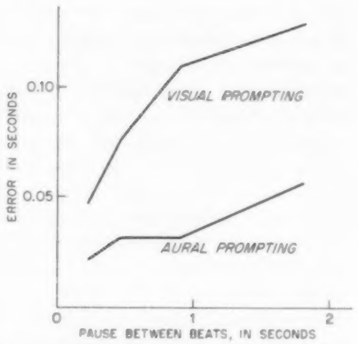


Fig. 1. Typical accuracy obtained when attempting to keep in tempo with a regular rhythmic beat.

A New Technique

A new post-synchronous recording system has been developed. It is based on the premise that the easier we make it for the actor to maintain synchronization, the more he can concentrate on dramatic interpretation.

If it were not for the question of dramatic continuity, the ideal situation would be to have loops of the shortest possible length. Phrase length is the most convenient length because, although short, it allows editing of the pauses that occur at either end. It is easy for an actor to maintain synchronization throughout a phrase, as in practice most phrases turn out to be less than two seconds in length. The phrase length distributions of three typical dialogue tracks are shown in Table I.

Because loops must have a cuing device and must be threaded up one at a time, there is a discontinuity between each loop; therefore very short loops are impractical.

The new system needs a guide track which was recorded at the time of shooting. This guide track is not cut up into loops. By the side of the guide track a control track is prepared, and control marks are placed on it corresponding to the beginning of each phrase. Depend-

Table I. Phrase Length Distribution for Some Typical Dialogue Tracks.

	Distribution of Phrases By Lengths					
Type of film	0–1 sec	1–2 sec	2–3 sec	3–4 sec	4–5 sec	More than 5 sec
Mystery	43.4%	40.3%	10.7%	4.7%	0.9%	
Drama	39.6	39	13.3	3.3	1.8	3.0%
Western	39.3	42.8	12.8	2.9	2.2	

Presented on October 5, 1959, at the Society's Convention in New York by Dennis Gunst, Fordel Films, Inc., 1079 Nelson Ave., New York 52.
(This paper was first received on August 26, 1959, and in final form on August 19, 1960.)

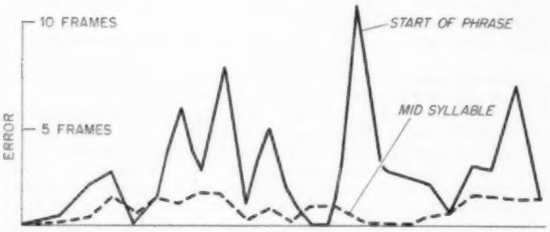


Fig. 2. Typical accuracy of starts and mid syllables of phrases in a long loop.

ing on circumstances, sometimes control marks are placed to pinpoint words in the middle of phrases, and sometimes a new guide track is made with all pauses between phrases removed.

The function of the control track is to position the new track against the guide track, phrase by phrase as the actor talks. It is actually the modulations of the actor's voice, together with the control track, which does this. In other words, the actor merely reads his script, and every time there is a control mark, just by means of the actor speaking, the new track is automatically placed in synchronization.

Monitoring

It is not difficult for the actor to maintain synchronization over these short sections, especially as he is monitoring his accuracy through earphones playing the guide track.

Example

For example, suppose we have on the guide track (in Fig. 3) the two phrases "Good morning" and "How are you," which are to be post-synchronized. On the control track, a control mark will have been placed at the start of the word "Good" and another at the start of "How."

The tape is stationary and the start of "good" is under the playback head which feeds earphones worn by the actor.

At his leisure the actor says the first phrase. A voice-operated relay consisting of microphone, amplifier and rectifier drives fast acting relays and solenoids which start the tape. At the same time the start of "good" is recorded opposite the start of "good" on the guide track.

It is essential that the tape gets up to speed in a few milliseconds or clipping may result. For this reason the capstan and idler are kept in constant motion, even when the tape is stationary, and the inertia of the feed and take-up reels are separated from the drive mechanism by storage loops.

The actor finishes the first phrase and the tape continues moving until the control mark corresponding to the start of the next phrase is reached, when the tape automatically stops. At his convenience, the actor says "How do you do," and this phrase is recorded opposite the old "How do you do" on the guide track.

If there is any error in synchronization it is soon detected over the earphones, and it is a simple matter to rerecord the phrase. A reverse button will return the tape at high speed to the start of the phrase, erasing the false take, so a new one can be substituted.

As no loops have to be reassembled the new voice track can be checked against picture without delay, using the sync track to interlock it with the projector. Again any error is easily corrected, as the control track will position the tape for erasure of any chosen section, and a new take can be inserted, without any editing.

In order to give maximum signal-to-noise ratio the widths of the guide, control and sync tracks can be sacrificed to allow maximum width to the new voice track.

Summary

We now have a new method of post-synchronous recording designed to take away from the actor the burden of keeping in synchronization and to place it on electronic controls. It can be used when

(1) It is difficult to obtain quality soundtracks in the field;

(2) dialogue tracks are ruined by electrical interference, wind or flutter;

(3) the original voice is not suitable;

(4) it is not convenient to be burdened with high-fidelity recording techniques; and

(5) greater visual freedom of the camera is required.

It should prove of great help, especially for location shooting, because it is so simple that now the director need not wait to use post-synchronizing as a last resort but can enjoy the flexibility, freedom and speed of silent shooting techniques without having to pay the penalty of a tedious looping session.

Demonstration Film

After the presentation of the paper a short demonstration film was projected. It showed an example of a post-synchronizing session in progress. Both the guide and new voice track were played for the audience and the use of the reverse button for correcting errors was demonstrated. The film ended with an example of the finished product with a new voice substituted for that of the original actor.

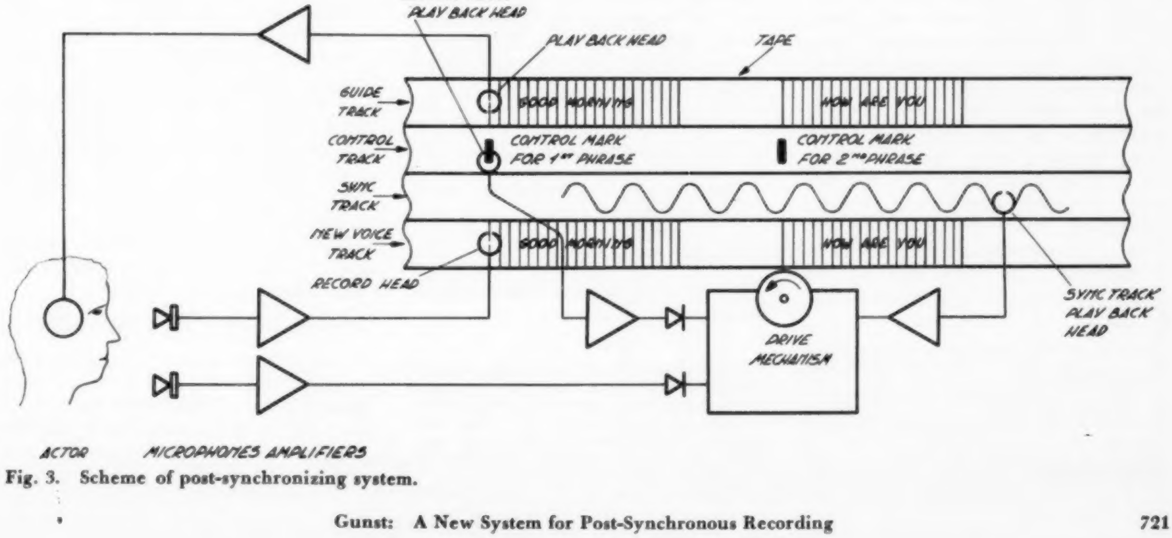


Fig. 3. Scheme of post-synchronizing system.

Discussion:

Col. Ranger (Rangertone, Inc.,): First, I wish to congratulate Mr. Gunst on a thorough presentation. I have tried this system and found it easy to use. I used this device at Mr. Gunst's request and I thought it was very simple and effective.

George Lewin (Army Pictorial Center): I would like to mention that I also had the privilege of trying the system. I think it was in a somewhat earlier stage. I wondered then what could be done to avoid the clipping of the very first word in a phrase which might happen with very weak sibilents or "f" sounds. The first sample that Mr. Gunst gave me did show some of this effect but I couldn't detect a bit of it in this demonstration here. I am curious as to the methods used in starting the system so suddenly.

Mr. Gunst: It has been one of my deepest concerns during the past years to get the machine to start up in less than a few thousandths of a second—up to speed almost as soon as you breathe—I think the main thing since I demonstrated the machine to you is that I have increased the signal-to-noise ratio in the control circuits. But I have also changed the equalization to give more bass.

Mr. Lewin: Presumably some sounds are a little too weak to get into the system and yet the actor's lips have already opened. Do you find this to be a problem?

Mr. Gunst: Well of course I had the control microphone extremely close to the actor's mouth and almost as he exhales the tape starts and it will start on extremely soft sound. The tube around the microphone seems to block out the unwanted noises from the surrounding room, but it picks up the actor's voice very well.

Mr. Lewin: Have a number of different actors worked with this? I was wondering what the average reaction is.

Mr. Gunst: No, but I plan to have different actors use this machine. That definitely is on my program.

Gordon Ellsworth (General Motors Photographic): What is the main problem in preparing your control track?

Mr. Gunst: If you have a reasonable guide track that is intelligible, it takes about five times the running time of the passage to make the control track. Its a fairly simple thing—just locating the starts of the phrases and punching a button.

Mr. Ellsworth: I see. This is a magnetic signal imposed on the tape—right?

Mr. Gunst: Yes, that is correct.

Mr. Ellsworth: You go through and mark up your script accordingly, and then as you play it you make your code marks.

Mr. Gunst: My usual method is to put the code marks on first and then I use the machine as a dictating machine to type out the script, because, you know, no actor ever follows the original script exactly, so you always have to correct the script afterwards.

Anon: Do you expect a project like this to be commercially available in the future?

Mr. Gunst: Well at present we are using a prototype machine at Fordel Studios. Certain negotiations are underway and it may soon be available commercially, I don't know exactly when.

Mr. Shelton: Do you have a patent on that?

Mr Gunst: Yes, the patent is pending.

Mr. Schuller: Does the cue mark correspond to the entire phrase, or just the beginning?

Mr. Gunst: Normally just to the beginning of the phrase. As we've seen, 80% of the phrases on scripts last less than two seconds. With average phrases such as "How do you do" or "How are you, John" the chances are that the rhythm of my "How are you, John" two months later in the post-syncing studio will be pretty accurate.

Mr. Lewin: To amplify Mr. Schuller's questions, are the little cue signals that you showed us only the little bits of tone used to stop the tape?

Mr. Gunst: Yes, I actually reversed this procedure in that I have a complete tone running right along the tape on a separate channel; to make my code marks, I erase little sections of it — $\frac{1}{4}$ in. in length at the beginning of every phrase.

Mr. Lewin: Would you care to give us an estimate as to the time required to record an entire reel of live sound.

Mr. Gunst: It will take generally 3 or 4 times the length of the reel if someone other than the original actor is making the recording, but if you're doing your own voice, you can under good circumstances, read through the script, getting only a few off-sync phrases which have to be re-done. This particular recording took about $7\frac{1}{2}$ minutes. I think that is the exact time it took to record.

New Sound-Retarding Doors for Motion-Picture Soundstages

By D. J. BLOOMBERG
and MICHAEL RETTINGER

After discussing the various factors determining the sound-retarding qualities of soundstage doors in general, various such doors, as used at Republic Studios, are described in detail. For the sake of convenience, they are classified as Inside Doors and Outside Doors. The former are double doors using a 1-in. cement plaster coating on each side of the steel frame of the door; the latter are solid concrete doors, 6 in. thick, with an internal steel frame.

The term "soundproof door" should be considered a relative term. A door may be made of 1-in. thick steel, weighing 40 psf (pounds per square foot), and still, a diesel truck passing near it may be heard in a disturbing manner on the other side if, for instance, music recording is to take place there. The door, therefore, is not "soundproof" in the sense in which a door may be lightproof, gasproof (hermetically sealed), waterproof, etc. For this reason the term "sound-retarding" (instead of "soundproof") has been used for the title of this paper, to be literally correct. It purports to mean a door which has a sufficiently high average sound transmission loss* to prevent all commonly occurring sounds near it from being picked up disturbingly by the microphones inside the soundstage.

Presented on May 2, 1960, at the Society's Convention in Los Angeles by D. J. Bloomberg, Republic Productions, Inc., North Hollywood; and Michael Rettinger (who read the paper), Industrial Electronic Products, Radio Corp. of America, 1560 N. Vine St., Hollywood 28.
(This paper was received on February 9, 1960, and in final form on September 28, 1960.)

* Transmission loss is the numerical measure of the reduction of sound-intensity level provided by a partition of any type (door, wall, window, etc.). The unit is the decibel. The average transmission loss is the arithmetic mean of the transmission loss at 128, 256, 512, 1024, 2048 and 4096 cps.

Causes of Sound Transmission Loss

Three factors determine the sound transmission loss of a door:

1. Mass per Square Foot

In general, for homogeneous partitions, the following conditions hold:

(a) The sound transmission loss of a partition increases by approximately 4.5 db every time the surface mass of the partition is doubled. For instance, if a partition weighs 10 psf, so that its transmission loss is 25.5 db at 125 cps, (cycles per second), then doubling the weight of the door, so that its surface mass comes to 20 psf, will increase the transmission loss to 30 db. Similarly, the sound transmission loss decreases by approximately 4.5 db every time the surface mass of a partition is halved.

(b) The transmission loss of a partition increases or decreases by 6 db when the test frequency is respectively multiplied or divided by 2. For example, if the transmission loss of a partition at 1000 cps is 40 db, then its transmission loss at 2000 cps is approximately 46 db, and at 500 cps it is 34 db.

(c) The general equation linking surface mass with the *average* sound transmission loss in decibels is

$$\text{Transmission loss} = 23 + 14.5 \log_{10} (W/S)$$

where W is the mass of the partition in pounds and S is the area of the partition in square feet. Thus, when the surface mass (W/S) of a partition is 10 psf, the average sound transmission loss (or that at 500 cps) will be 37.5 db.

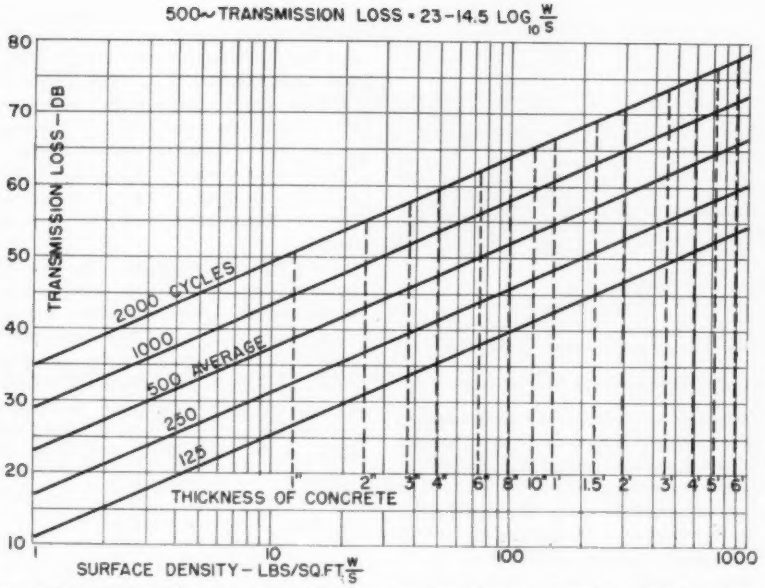


Fig. 1. Sound transmission loss of a homogeneous partition as a function of surface density, for different frequencies.

Figure 1 shows in graphic form the various relationships discussed above. From Fig. 1 it is readily evident that when a partition with an average transmission loss of 50 db is desired, the surface mass should come to approximately 70 psf. This surface mass is equivalent (as also shown on the figure) to that of a 6-in. thick concrete partition.

In Table I is given the surface mass of commonly encountered building materials.

Table I. Surface Mass of Building Materials.

Material, 1-in.	Surface density, psf	Expected transmission loss, db
Plywood . . .	2.5	29
Concrete . . .	12.5	39
Aluminum . .	13.75	39.5
Glass	14	40
Steel	40	46
Lead	60	49

2. Seals

Many sound-retarding doors — relatively heavy doors — do not exhibit the calculated sound transmission loss because the door seals are inadequate. Consider a door weighing 20 psf, jammed up against a 1-in. thick layer of foam or sponge rubber. The average transmission loss of the door itself comes to about 43 db. The 1-in. thick porous rubber, however, weighing barely a few ounces per square foot, may have a transmission loss of only 5 db. The crack width (when the door is closed) is no more than $\frac{1}{2}$ in. Still, the combined area of the $\frac{1}{2}$-in. seal for even a small door, say 3 by 7 ft (21 sq ft), comes to almost 1 sq ft or 5% of the door area. It is obvious, therefore, that ordinary rubber compression seals are very weak sound transmission links in the case of sound-retarding doors.

When noise passes through the seal of a door it is diffracted so much that it spreads out in all directions after passing through the seal, as though the seal were itself a source of sound. Thus, the noise may impinge on the outside stage wall all along the structure, but is able to pass through it only at the narrow seals; however, inside the stage the noise emanating from the seal will spread so much as almost to give the impression that it is passing directly through the wall.

3. Panel Damping

A panel which is able to execute large excursions at one of its natural resonant frequencies is able to transmit sound of that frequency quite readily, even though it may exhibit large transmission losses at many other test frequencies. This condition is generally ameliorated by the application of a damping material to the panel.

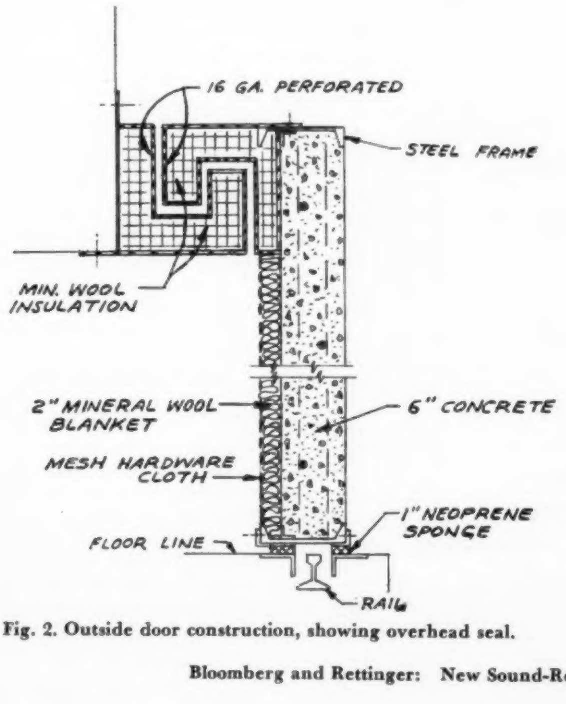


Fig. 2. Outside door construction, showing overhead seal.

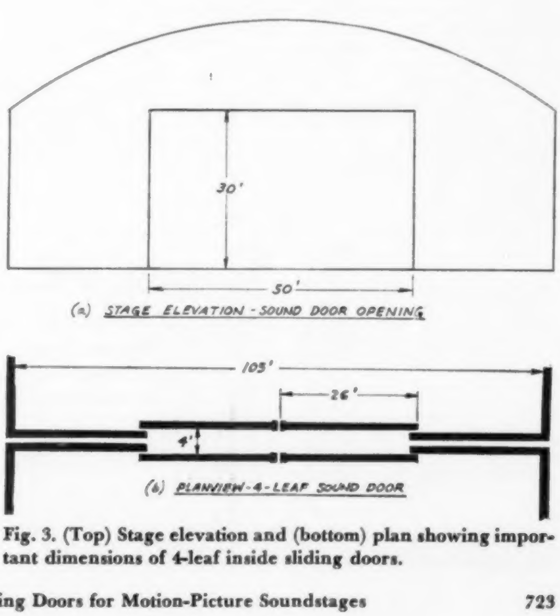


Fig. 3. (Top) Stage elevation and (bottom) plan showing important dimensions of 4-leaf inside sliding doors.

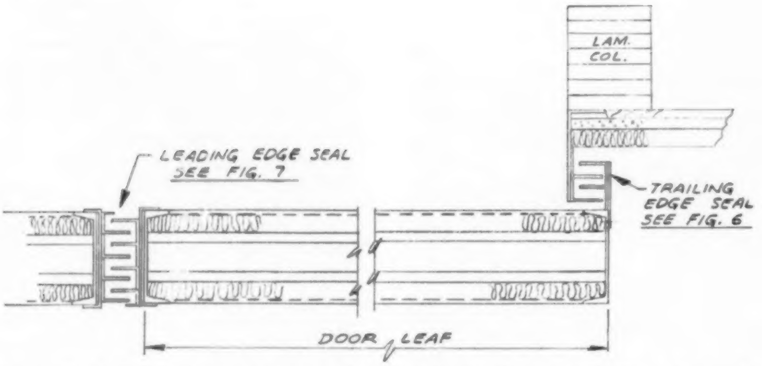


Fig. 4. Single inside door leaf construction, showing leading- and trailing-edge seals.

From the above description of the factors influencing the transmission loss of partitions, it is readily evident what should be done to secure highly sound-retarding doors. These principles were followed carefully in the design of several large soundstage doors at Republic Studios built by the Ferguson Door Co. of Los Angeles. The following constitutes a detailed description of these doors, which may, for the sake of convenience, be treated under two headings — Outside Doors and Inside Doors.

Outside Doors

Because it is usually possible by means of red "blinkers" to control the flow of traffic to some extent in the streets surrounding a soundstage, outside doors are usually single doors. This does not mean that they may be of flimsy, lightweight construction. In this instance, however, since the new sound stages are so close to Ventura Boulevard it was necessary to employ relatively massive doors, even though they were single. For this reason 6-in. thick lightweight concrete was selected for the main mass of the 20 by 20 ft doors. The door frame, heavily braced, was made of steel, and the concrete was poured into the frame near the stage to avoid expensive transportation of the doors. The casting was done on a properly prepared concrete slab, and the outside parts of the steel frame acted as the forms for the concrete.

When finished, each door weighed 15 tons, or 75 psf. Of this surface weight, approximately one third was due to the steel frame itself, and two thirds to the concrete. It is seen, from Fig. 1, that this surface mass provides an average transmission loss of 50 db. Thus, the outside noise may be as high as 80 db above threshold without raising the stage noise level above the 30-db value generally recommended as the maximum required for satisfactory sound recording of motion pictures.

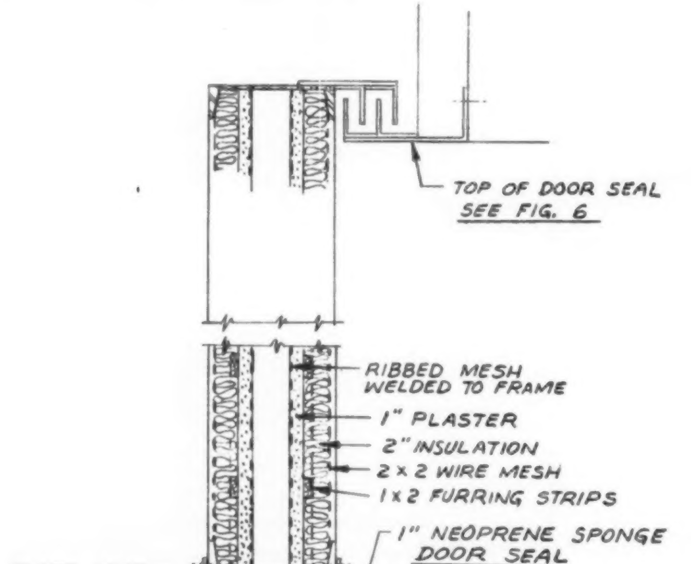


Fig. 5. Sectional view of single inside door leaf.

The top and the trailing edges of the door fitted into metal pockets which consisted of perforated steel behind which had been installed 2 in. thick layers of mineral wool. These seals, therefore, were essentially sound filters, because sound resists traveling around corners. What sound does by diffraction bend around the edges of the filter pockets becomes highly absorbed by the mineral wool.

An effective bottom seal was achieved by lowering the door by gravity, and permitting its mass to compress a ½-in. thick and 6-in. wide high durometer rubber strip. No clamp of any practical type could have compressed the rubber as well as the heavy door itself. To achieve the door lowering, recourse was taken to a mechanical device which requires only that a wheel be turned eight times to secure complete lowering or complete raising (about 1-in.) of the door. After the door has been raised, another wheel permits the lateral movement of the door for normal closing or opening. This wheel is very easy to operate. Figure 2 shows details of construction for this 6-in. thick concrete door.

Inside Doors

In the case of two adjacent sound stages separated by a door it is only infrequently possible to control the noise in one stage while sound recording takes place in the other. Hence it became necessary not only to employ a double wall for the partition between the stages, with each wall resting on its own foundation, but also to construct double doors. A detailed description has previously been provided for such a double-wall partition between two adjacent soundstages without a door in the partition.[1] This type of wall construction proved so effective that it was used again in the construction of the partition between the adjacent stages which were to have a double door between them.

The door opening itself was approximately 50 ft wide and 30 ft high and had to be in the middle of the 105-ft wide partition. Since it was not possible to use one set of double doors (with each door 50 ft wide), two sets of sliding doors, each approximately 26 ft wide, had to be used. Figure 3 shows an elevation of the stage and a plan of the double doors. Each door had a surface area of almost 800 sq ft and was thus twice as large as the outside doors previously discussed.

To facilitate construction, it was decided to employ, not poured concrete as for the outside doors, but a layer of 1-in. thick concrete or stucco on each side of the steel frame of the door. The stucco was applied to ribbed metal laths which had been welded to the frame. Mineral wool blankets, 2 in. thick, were then applied to each side of the door to act as vibration dampers as well as sound absorbents for the soundstages

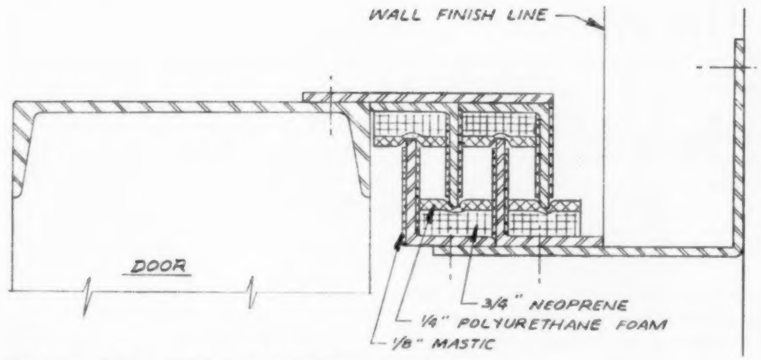


Fig. 6. Detail of typical door seal—trailing edge.

and for the interspace between the two sets of doors. The total mass of each 26 by 30-ft door was estimated as 15 tons and the surface mass as 39 psf. From Fig. 1 it is seen that a single homogeneous mass of such surface density provides an average transmission loss of 46 db.

It should not be assumed that two such doors, even when resting on separate foundations as these doors did, will give a total transmission loss equal to the arithmetic sum of the two transmission losses, or 92 db. However, it was decided to come as close as possible to such a high transmission loss value, so as to permit practically any type of activity in either one of the two adjacent stages, including that of firing a 45-caliber pistol in one stage, while sound recording took place in the other stage. To achieve such results, the doors were installed, not in the interspace of the double walls, but on the stage side of each wall. This meant that the distance between the doors was practically 4 ft. It has long been recognized in the field of architectural acoustics that the transmission loss of a double wall, and hence also of double doors, is a function of the distance between the walls.[2,3] Increases in the resulting sound transmission loss of as high as 2 db/in. have been obtained by widening the space between the partitions, although a value of 1.5 db/in. is more common. Beyond a certain value of interspace, however, the insulation increase becomes asymptotic and approaches the stage of "diminishing returns." To assure a maximum transmission loss for the combination double door, the inside face of each door was covered with 2 in. of mineral wool, to obtain as great a "free air-space," as possible rather than employ another enclosure 4 ft wide, acting as an acoustical coupler between the two sets of doors.

Again much thought was given to obtaining effective door seals. Figures 4, 5, 6 and 7 show details of the seals at the abutting edges, at the top of the door, and at the "trailing" edges of the door. As in the case of the outside doors previously described, the doors ride on a railway rail, and can be lowered by mechanical means.

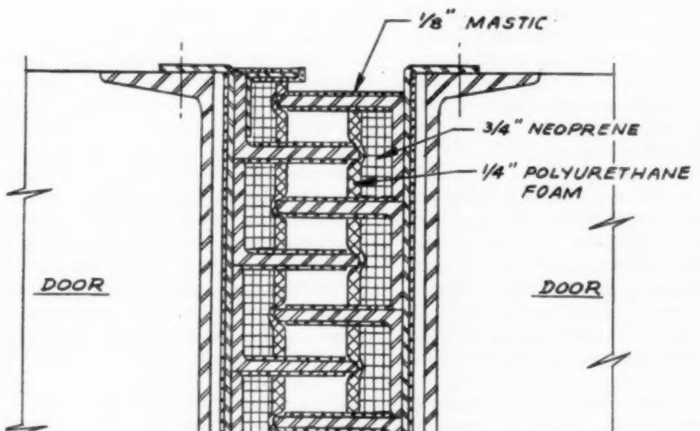


Fig. 7. Detail of typical door seal—leading edge.

The movement of the doors was so easy that manual rather than electrical actuating means were used.

A single operating wheel was devised for moving each door horizontally or vertically, the respective movement being controlled by a shift lever.

Figure 8 shows the measured transmission loss characteristic of an outside door.

No transmission loss measurement was made of the inside doors, since it exceeded the power-handling capacity of all readily available loudspeakers. However, as noted before, the firing of full blank 45-caliber pistol shots in one stage cannot be heard in the adjoining one. From measurements with a General Radio Co. Peak Level Meter and a Scott Half-Octave Analyzer, using such 45-caliber pistol shots as noted above for the signal source, it must be assumed that the transmission loss of the inside doors exceeds 60 db at 100 cps.

References

1. D. J. Bloomberg and M. Rettinger, "Tripartition of a sound stage," *Jour. SMPTE, 66:* 285–287, May 1957.
2. George L. Bonvallet, "Retaining high sound-transmission loss in industrial plants," *Noise Control, 3:* 61, Mar. 1957.
3. Jack B. C. Purcell, "Control of air-bourne sound by barriers," *Noise Control, 3:* 20, July 1957.

Discussion

Anon: What advantage was gained by using double doors for inside doors, and what reason would there be for not using a double-door system for outside doors as well, and obtain that advantage?

Dr. Rettinger: The reason is that the outside noise of a soundstage can be controlled economically by blinkers. In other words, one can stop the traffic flow by a flag man for a limited period, and not much loss is suffered. Whereas, if one tried to stop the inside activity of an adjacent soundstage, holding up several hundred extras in the production of a picture — that would be costly. So it was decided to make the inside doors extremely sound-insulated, and the outside doors just sufficiently sound-insulated, so that the unavoidable and uncontrollable noise would not be passed through the door.

Anon: I was thinking more in terms of the simplicity, or perhaps it wouldn't be so simple to do double-door construction, for outside doors; but I was thinking more that you had much lighter construction and still attain the same amount of loss of transmission of your sound by that double-door construction.

Dr. Rettinger: Yes, that's true. Concrete is cheap, but it is the mechanisms involved that become costly when two doors are employed.

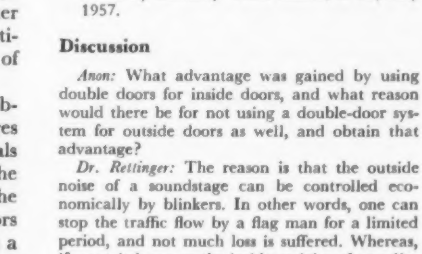


Fig. 8. Transmission loss characteristic of outside door.

Oskar Messter and His Work

By ALBERT NARATH

This is a survey of the life of Oskar Messter, founder of the German Motion-Picture and Film Industry, and of his achievements in the development of cinematography.

OSKAR MESSTER, founder of the German Motion-Picture and Film Industry, was born in Berlin on Nov. 21, 1866. His father, Eduard Colmar Messter, had founded the firm of Eduard Messter in 1859. The senior Messter was only nineteen years of age and possessed very little capital when he founded the firm, a machine shop, which chiefly produced optical and medical instruments.

Today it might appear strange that a firm producing instruments for science and research, such as ophthalmoscopes, laryngoscopes, and microscopes, would also produce equipment for stage and variety artists. The explanation is that optical equipment was of unit manufacture and could be built only by specialty firms. When Eduard Messter built equipment for the well-known magicians Bellachini and Basch, he occasionally presented his son with copies of these implements. Oskar Messter mentions in his autobiography that a musical box, the construction details of which he carefully inspected, had a ratchet-type lock for the spring winding, which was similar to a maltese cross.

The occupation with these varied instruments was not only stimulating but it also showed him how problems brought to his father were solved. It is no surprise that he, following his preference for mathematics and physics, decided on a technical career. He was only 26 when he took charge of his father's enterprise, and he sold his first motion-picture projector on June 15, 1896 (Fig. 1). This date can be considered as the birth date of the German motion-picture industry.

The Era of the Silent Film

The Beginnings of Cinematography and the Motion-Picture Projector

Like nearly all inventions, cinematography had its predecessors. One should avoid making sharp distinctions in a technical development, where there is actually a constant flow of transition. Many inventions in cinematography were made and patented about the same time by different people in different countries. Frequently, due to lack of communication, one individual was not informed about work done by others in an identical field. The same situation exists today, and just as frequently as in the past because the growing volume of papers can hardly be mastered.

At the time Oskar Messter took possession of his father's business, Anschütz had already introduced his "Rapid Viewer." Edison's Kinetoscope was on display at Castan's Panopticum in Berlin (summer of 1895) and Anschütz demonstrated his projector on Nov. 25, 1894, in the Post Office Building on Artillerie Street. He held performances and charged admission in the Parliament Building on Leipziger Street from February 22 until the end of March, 1895. Ultimately, the Skladanowsky brothers had the first performance of their Bioskop on Nov. 1, 1895, at the Winter Garden. This can be considered as the earliest date in Europe for paid motion-picture public performances.

By 1897 Oskar Messter had become so involved with the new art that he had published a 115-page illustrated catalog in which he offered his film projectors: the Kinetograph and the Thaumatograph with all their attachments, cameras for professionals and amateurs, also perforators and processing and printing equipment.

Oskar Messter delivered his first projector on June 15, 1896, to the showman Rogulino in Moscow. This instrument had a five-slotted maltese cross with a ratio of about 2.6:1 and a one-pin disc without a fly-wheel (Fig. 2). Drive and film path were mounted on a brass plate which was transverse to the optical axis. The hand crank was attached to a crankshaft which drove the pin disc through straight-toothed wheels. It was on the left side of the projector and had to be turned counter-clockwise. The single-blade, rotating shutter which was driven by beveled gears was between the aperture and the objective. The film path and gate did not have slide rails, but were velvet-covered. The transport sprocket below the aperture had a brass pressure roller. The film was unwound from a round box of about 60-ft capacity. It was open on the service side but had a small safety catch. The film ran free in a basket. The lamphouse had doors on both sides and on the back, was lined with asbestos and contained an arc lamp which could be observed through a small ruby glass window. The condenser had a diameter of 105 mm. In addition there was a sliding shutter which could be operated from the left. The instrument was delivered with six Edison films, each about 55 feet long. An illustration of this first projector is not in existence.

Seemingly, the projector satisfied the customer, because he reordered films by the end of July and October of 1896. During 1896 Messter obtained orders for 64 projectors, of which 22 were from abroad (Europe). One projector was installed in a theater owned by Messter in Berlin at 21 Unter den Linden. Furthermore, Messter projectors were used in the Apollo Theater starting the first of November and in the Hansa Theater in Hamburg on Dec. 1, 1896.

It was a lucky decision that Messter used a maltese cross in his projector from the start. In the beginning he used a 5-slotted cross, just like the one used by Max Gliewe from the Optical Works Gliewe and Kügler, Berlin.* Because of the smoother transport Messter replaced this in 1896 by a 4-slotted maltese cross (Fig. 3). One like it with a tangential entry is pictured in D. R. P. 127913,†

A contribution by Albert Narath, Professor at the Institute for Applied Photochemistry and Film Technique of the Technical University, Berlin, West Germany. This manuscript in German was translated into English by Dr. Eric I. Guttman, Manufacturing Experiments Dept., Kodak Park, Eastman Kodak Co., Rochester 4, N. Y.

* He worked closely with Mr. Betz, an engineer of the firm Bauer & Betz. Both obtained registered designs (Gebrauchsmuster) and trademarks which are contained in the first catalog of Messter on page 3.

† All patents mentioned (except one) are Deutsches Reichspatents (German State Patents) and therefore the letters "D.R.P." will not be repeated.

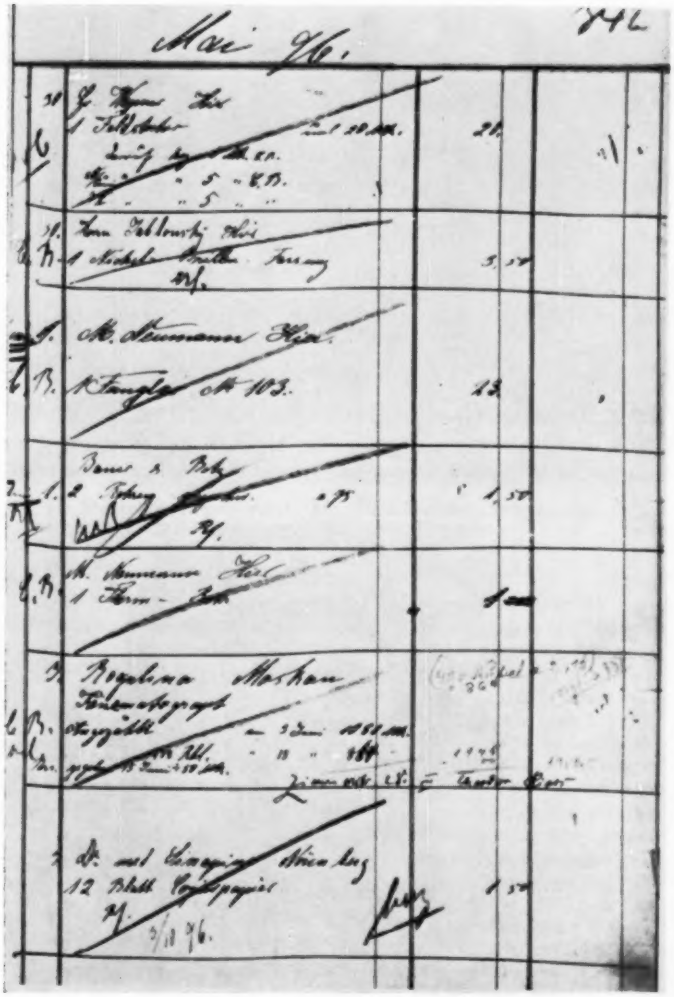

Mai 96.
742

Fig. 1. Sale of the first projector by Oskar Messter to showman Rogulino in Moscow: Recorded on page from ledger from May 1896, with the entry June 3: 1,081 Marks down-payment; and June 15: on balance of 400 Rubels = 864 Marks were received.

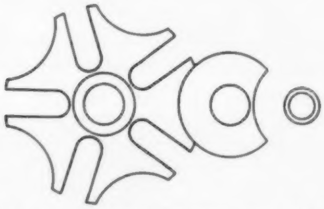


Fig. 2. 5-slotted maltese cross with a ratio of 2.6:1.

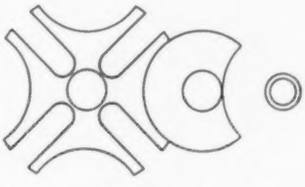


Fig. 3. 4-slotted maltese cross, ratio of 2.5:1.

June 26, 1900. This is reproduced in Fig. 4. It is the 4-slotted maltese cross with tangential entry which is missing from U.S. patent 578,185, issued to Armat in 1896, and which was the necessary prerequisite for a smooth movement.

Immediately after building the first projector, Messter introduced improvements on the new model. It turned out that the velvet in the aperture scratched the film. He changed to edge guiding by means of spring-loaded rails. The pressure roller, which pressed the film against the drive sprocket, contacted the film only on the edges, and not in the picture area. Later Messter chose pressure pads. To obtain a well-positioned, steady image, he took pains to see that all fast rotating parts were balanced. The single-blade shutter received a counterweight and to the shaft of the one-pin disc he then added a flywheel. Feed and take-up sprockets were installed, also a wind-up and fire-resisting magazine.

Important also was the installation of the three-blade shutter (invented by Theodor Pätzold, Berlin) which eliminated the flicker (1902) and the picture framing mechanism (invented by Max Gliewe in 1900). In 1913 Messter boxed the entire movement and equipped it with automatic oiling. Between 1896 and 1913 he brought out 17 types, a proof that he constantly tried to add improvements. Figure 5 shows the projecting mechanism of the Kinetograph, System "Apollo," Model 1896. Figure 6 shows the Kine Messter Projector, Model 1908 with changeable base. Figure 7 shows the mechanism of Messter's "Armored Movie," Model 1914. Figure 8 shows the same projector open.

Besides many registered designs,‡ he obtained patents in the field of projector construction. Some of his patents were as follows: 126353, Sept. 20, 1900, and 212763, Apr. 5, 1908, for fire-protective installations; 222863, Mar. 17, 1908, for a supplementary speeding of the advance mechanism; 216236, June 14, 1908, for image positioning; 280618, Dec. 21, 1913, for a magnetically actuated windup; and finally noted is 330508, June 12, 1919, for a windup with tapered elements around the shaft. Interesting also is 278228, Feb. 12, 1913: With incandescent bulbs in the projector it was difficult to obtain uniform illumination without a point light source; the patent 278228 protected a method where the light source rotates around an axis which is perpendicular to the optical axis, whereby it behaves like a uniformly illuminated disc.

By 1900 Messter was interested in the problem of an optically compensated projector. First he used a ring made up of concave lenses. Later he changed to a many-sided rotating prism. In 1909 he began work with Dr. Thorner, an opthalmologist and professor of physics. Patents were recorded under either's name. For an optically compensated projector with two tilt mirrors and rotating mirror segments Messter obtained the German patents 230022,

‡ "Registered design" or "petty patent" or *Gebrauchsmuster* (DRGM).

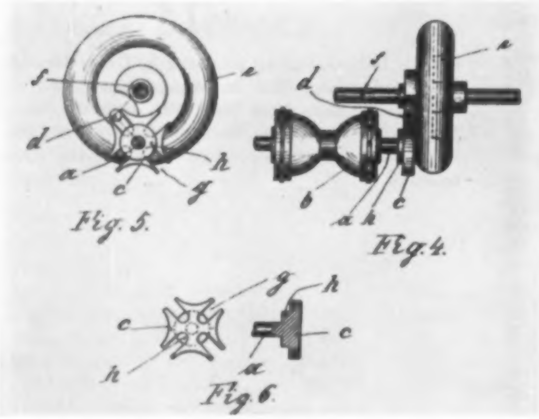


Fig. 4. 4-slotted maltese cross with tangential entry. Figures 4, 5, and 6 are from the Messter patent 127913 (6-29-1900).

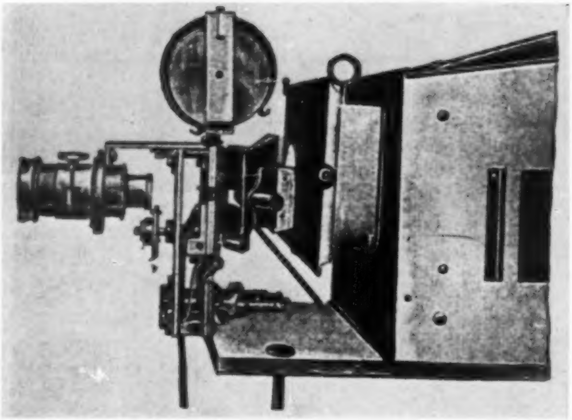


Fig. 5. Kinetograph-Messter, System "Apollo" from Fig. 10 of Messter's first price list. (printed Oct. 1897, published 1898).

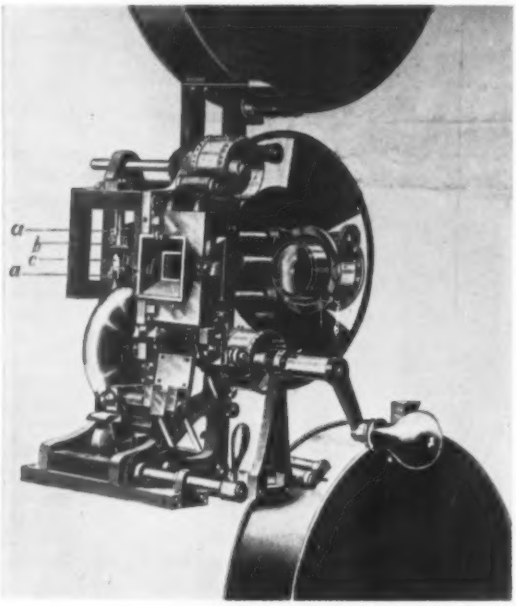


Fig. 6. Kine-Messter-Projector, Model 1908, with changeable base.

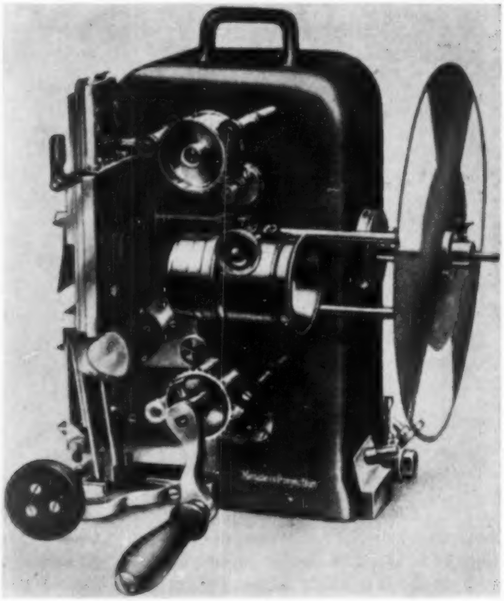


Fig. 7. Messter's Panzer-Kino, Model 1914; drive viewed from service side.

Nov. 25, 1908; 331550, Mar. 21, 1918; 332273, Aug. 12, 1919; and 336649, Aug. 12, 1920. These experiments, stretched over many years, were expensive; on the other hand they proved that Messter did not leave anything untried and caught every opportunity to solve a problem by himself. From the many who during the years occupied themselves with this problem, only Mechau achieved a design which was practical and is still used for special effects.

The Film Material

With his first projectors (1896) Oskar Messter furnished Edison Films, which he purchased in London from Maguire and Baucus. However, when he decided to take his own pictures he had to find a dealer of raw films. The choice was between Blair and Kodak (Eastman Photographic Materials Co., Ltd.) in London, and Lumiere in Lyon (France). Blair and Kodak furnished longer strips free of splices. Since Kodak's films were the best, Messter intended to contract a large amount. The deal did not come through because Kodak shipped only for cash, which condition at that time Messter could not meet. In 1897 he saw Mr. Eastman in Berlin and obtained sufficient credit in spite of the policies of the company. One can conclude from this that Eastman was greatly impressed by Messter's work. Since Kodak delivered the films unper-

Fig. 8. Same model as Fig. 7, from back; view looking into the housing.

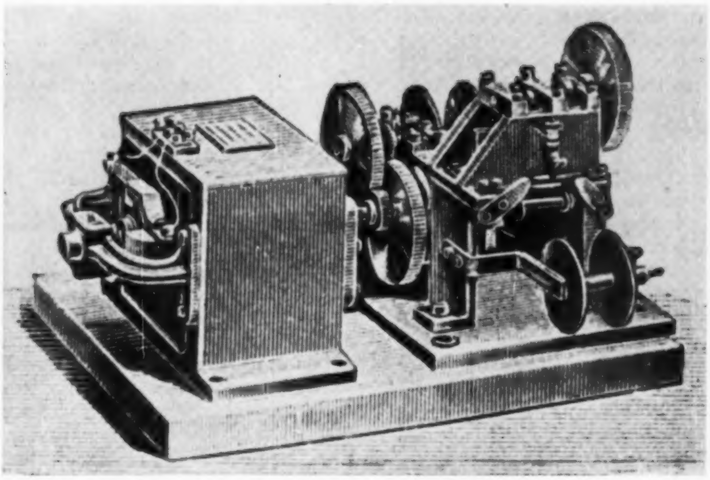


Fig. 9. Motor-driven perforator (Fig. 17a in Messter's first catalog).

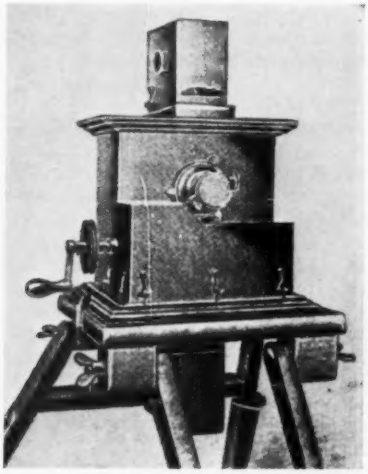


Fig. 10. Messter's first professional camera. Thaumatograph used as camera (Fig. 9 in Messter's first catalog).

forated, Messter built his own perforator, choosing a perforation which was in between the Edison and the later Pathé. A few years later he changed to the Pathé perforation. Figure 9 shows a perforator from 1897, which used a maltese cross drive, advanced the film always four pitches at a time and punched four pairs of holes. Later (1905-1910) Messter changed to single-hole perforating with a claw movement because he wanted to be able to change the pitch of the film to compensate for shrinkage in order to obtain perfect prints.

The Recording Camera

Before Oskar Messter attempted to build his own camera, he made an interesting preliminary experiment, which could be done cheaply. He used his projector mechanism as film transport and the rotating shutter as an instantaneous shutter. He converted his living room at 29 Georgen Strasse in Berlin into a camera obscura by pasting brown wrapping paper over the windows. In one window pane he installed a wooden board with two holes, inserting into one the objective lens and a red glass disc into the other. He observed through the red disc when a railroad train came by near his apartment and then put his mechanism in motion. The camera was loaded with 30 inches of regular roll film (used normally to take $3\frac{1}{2}$ by $4\frac{1}{4}$-in. pictures) slit to 35mm width. After processing the film in a wash basin, it showed that the experiment was successful and yielded sharp single exposures. Messter then built the first camera from an existing projector mechanism, effecting slight changes on the shutter and the aperture.

Near the end of October, 1896, he sold his first camera, while the camera by Lumiere was still kept secret. Messter's first cinema catalog lists two types, a professional (Fig. 10) and an amateur camera (Fig. 11). Both contained a maltese cross drive. The amateur camera, with the addition of a film holder, could also be used as a projector, as shown on the illustration (Fig. 12). These two cameras had to be loaded in the dark; only later did Messter use magazines, similar to the Messter-Camera 1900, in which the magazines for the negatives were located below the camera drive, a logical design in regard to the location of the center of gravity. Another handy camera (Fig. 13) had interchangeable metal magazines for 90 feet of film. These magazines were side by side and he obtained patent 127543, Nov. 11, 1900, for this novel arrangement.

The handy Kine-Messter-Camera 1900 was used by many explorers, such as the Africa explorer Prof. Schillings, Prince Adolph Fredrick of Mecklenburg and many others. About 1910 Messter introduced the claw transport for his camera, also for the Studio Camera Model XIV (Catalog 1913/14). In this camera the open sector of the rotating shutter could be changed during exposure with the aid of the movable shutter blade. The exposure time could be changed thereby, down to complete dimming. This arrangement was especially important for fading one scene into the other and for trick shots (patent 324194, April 1, 1914).

The Processing and Printing of Films

After the first makeshift equipment Messter used drums for processing, on which 60 feet of film could be wound. For drying he used drums of several meters in diameter. In 1898 he used developing racks with pins and trays which he had seen in England. Later he changed to troughs 5 feet tall and used racks holding about 200 feet of film. His patent 304738, July 14, 1914, in which he used very long pipes for the processing of film, going through many floors of the building, did not prove important. (Patents 352083, 352084 and 352085, all dated April 27, 1920, were assigned to the Bavarian Polytechnical Research Society at Tegernsee, a foundation established by Messter.)

The first printing experiments involving films were made with a homemade box having a slot 3mm wide and a transport roller with 20 teeth. After these experiments, he built a printer with maltese cross gear. He brought the two films into contact only in the printer gate and transported them below it by two separate sprockets. It is remarkable that Messter obtained a patent as early as 1907 for a printer design (144136, Dec. 20, 1907) where the positive and negative films are held together in the gate by compressed air. The equipment was built originally for paper prints; the patent, however, protects all kinds of contact prints.

The difficulties involved in film printing are shown by patent 338773, June 12, 1920. Due to lack of standards, films taken with different cameras could have the frame-line in different locations. The patent describes a printer with an attachment between the stock roll and the take-up roll for the positive which permits the calibration of the differing frame-lines into a common position.

A method of optical printing was also patented by Messter (121591, Feb. 18, 1900). It was orginally intended for his "Westpocket living photographs" and for his "Kosmoskop," which required enlarged paper prints made from motion-picture film negatives. This patent protects also any kind of optical prints, the patent claim being: "common drive providing the advance of both strips in a definite relationship to each other."

Even after his film companies were taken over by UFA in 1917, Messter's firm processed its own films until 1921.

The Motion-Picture Studio

Messter opened his first studio in November, 1896, on the fifth floor of 94a Friedrich Strasse. The illumination consisted of four Körting & Matthiessen 50-amp arc lamps. They were on portable mounts, so that Messter was able to take motion pictures for the first time of the ball held by the Berlin Press Club at the beginning of the year 1897. In 1902 he purchased in Cologne 24 Regina-Arc lamps and experimented later with arc lamps of Weinert-Berlin, which were enclosed in glass covers. He found help through Carl Froelich, who later became a famous movie director. Froelich left the electrical industry and became his apprentice without pay. Messter then moved to a studio at 156 Friedrich Strasse, which became his first glass studio with southern exposure. The previous studios all had northern exposure, since they were built for portrait photography. In spite of his arc lamps, Messter still could not do without the sun. He considered building a floating studio on Lake Rummelsburg, to be able to rotate his studio and become independent of the sun. Some studio shots had to be retaken occasionally because his "sun watcher" erred in predicting the exposure time. Due to the variability of daylight Messter returned to the somewhat more dependable arc light. Most of the time he used mixed lighting.

Since the size of the business increased steadily, the present quarters became insufficient, and in July, 1911, he moved to the 5th and 6th floors of buildings at 31 and 32 Blücher Strasse. The glass studio there measured 46 by 78¾ feet with 24½ feet height. Besides regular production many sound films were also made there. To satisfy the increasing demand he installed a motor-driven suspension bridge under the glass roof, which permitted movement of either the camera or the subject.

By the end of 1917 he acquired the Literaria Studio at Berlin-Tempelhof. It was built in 1913 by Alfred Duskes for Pathé Frères to produce their German films. Messter started using it early in 1919. At the same time he moved his printing facilities there from 32 Blücher Strasse.

In 1914 he erected the first large film studio, for the Sascha-Messter-Film Company in Vienna in the Sievering District. It began operation in 1915 and is still operating today.

Color Film

Messter made some of his early sound films and his "Alabastra Films" (see below) hand-colored. He had become interested in color film around the turn of the century. For the additive system he built cameras with three objectives, whereby he divided the picture area into separate fields according to diverse methods. One of these cameras and many other instruments of importance to the development of cinematography are at the German Museum in Munich.

The "Three-Dimensional" Film

A process to achieve a three-dimensional screen image interested Messter from the beginning. A patent application for a stereo rapid viewer dated July 23, 1896, is one of the proofs. (The patent was not granted.)

In 1909 Messter learned about the existence of Engelmann's process which was based on Pepper's ghost images, whereby the audience viewed the projected cinematographic image showing persons apparently standing on the floor of a dimly illuminated stage. The height of the persons who appeared to be moving freely about the stage was about 30 inches. Due to dimensional differences on the film, viewers "saw" the persons move both back and forth, so that an illusion of depth was sensed. Messter developed a projection system which he named "Alabastra." He showed the hand-tinted films with music and song accompaniment and received excellent press reviews. In spite of this his specially equipped Alabastra Theater was short-lived. Nevertheless, at the Court Theater in Darmstadt, the Czar of Russia, his son and Prince Heinrich of Prussia attended similar performances.

Special-Effect Photography

To eliminate defects in background projection, Professor Thorner perfected a method whereby the background was projected with a special projector over a partially transparent mirror onto a large

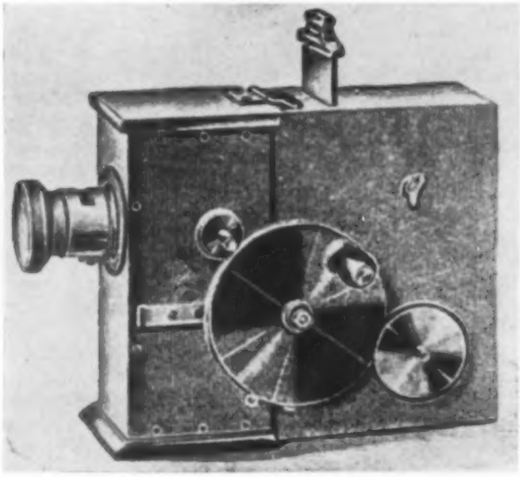


Fig. 11. Messter's Amateur-Kinetograph (Amateur camera, Fig. 6 in Messter's first catalog).

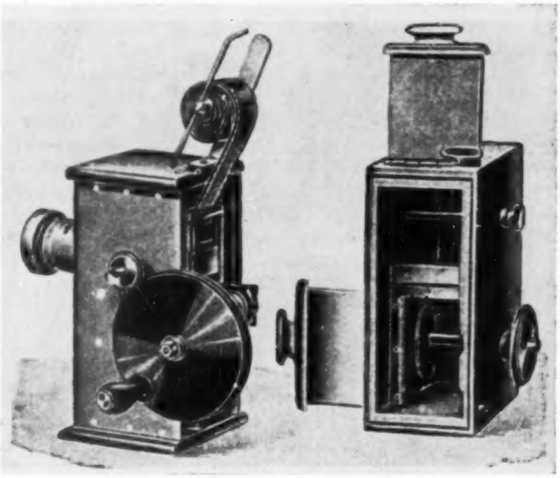


Fig. 12. Same as Fig. 11 — Left: instrument with mechanism ready for projecting. Right: Double magazine for picture taking (Fig. 5 in Messter's first motion-picture catalog).

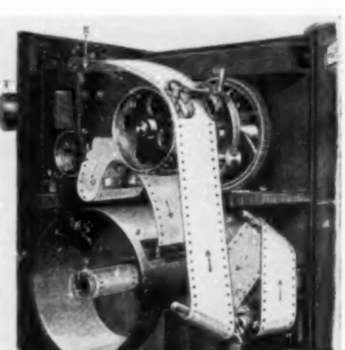


Fig. 13. Messter's portable camera from 1900, with exchangeable metal magazines and 30-meter film capacity.

concave mirror in front of which the actors moved. The concave mirror and the objective combined the image of the actor with the background on the film (patent 598712, May 19, 1932). Messter carried out practical experiments with this system. It could not gain acceptance, because the manufacture of similar mirrors was expensive and dimensionally limited.

The Amateur, Instructional and Commercial Film

In his first price list Messter had the previously mentioned amateur camera (Fig. 12). Later he added a projector with a maltese cross drive which was mainly intended for school use.

To save on expensive film, he constructed in 1908 the "Salon-Kinemesster" with four rows of pictures on a 35mm strip (patents 235550, 224610 and 222393, all dated Feb. 24, 1909; and 225878, Sept. 30, 1909). The single frame of the 35mm film was subdivided into 16 pictures. The adjoining strips were projected alternately from top to bottom and from bottom to top after appropriate displacement of the objective and the light source. The 2-meter long film equalled in number of frames and projection time that of 32 meters (105 ft). A Nernst lamp was used as a light source. By using a metalized screen, he obtained a picture size of 3½ by 6½ feet. Grain size of films of the day did not permit greater magnification.

An even smaller piece of equipment was the "Fun Movie Projector," a miniature device which projected small pictures on a white surface such as the shirt front of a person (patent 193026, Nov. 14, 1906).

After 1897 Messter also engaged in the production of small booklets whose pages had to be flipped quickly. For the booklets, and for his "Kosmoskop" which worked like the Mutoscope and permitted the viewing of phase-pictures printed on a paper strip, he developed appropriate processing equipment (patents 108715, July 10, 1898; 107607, Nov. 8, 1898; 106784, May 13, 1899; 108810, July 7, 1899; 161163, Dec. 12, 1902; 154513, Dec. 20, 1902).

For commercial or advertising work Messter constructed a projector mounted in a box. By means of a mirror the pictures were projected on the opened box lid (patent 263818, Sept. 21, 1912).

Applications of Cinematography

Messter occupied himself extensively with developing motion-picture equipment for use in technical and scientific fields. In 1897 and 1898 he developed a high-speed camera for film 60mm wide. The frame size was 30 by 55mm and its speed 100 frames per second. Among other things he photographed the fall of a cat together with a stop watch made by Hipp (Fig. 14). He worked on important problems during World War I for the German Army, Navy and Air Force. For the Navy he developed a camera which registered hits fired from warships at floating targets. The 35mm film moved from right to left and reproduced the target and its surroundings on a picture size 20 cm (7.874 in.) wide by 2.5 cm (0.984 in.) high. Simultaneously a clock and a glass scale were photographed. The zero point on the scale had to be adjusted onto the target. Each film advance amounted to 22.5 cm (8.858 in.).

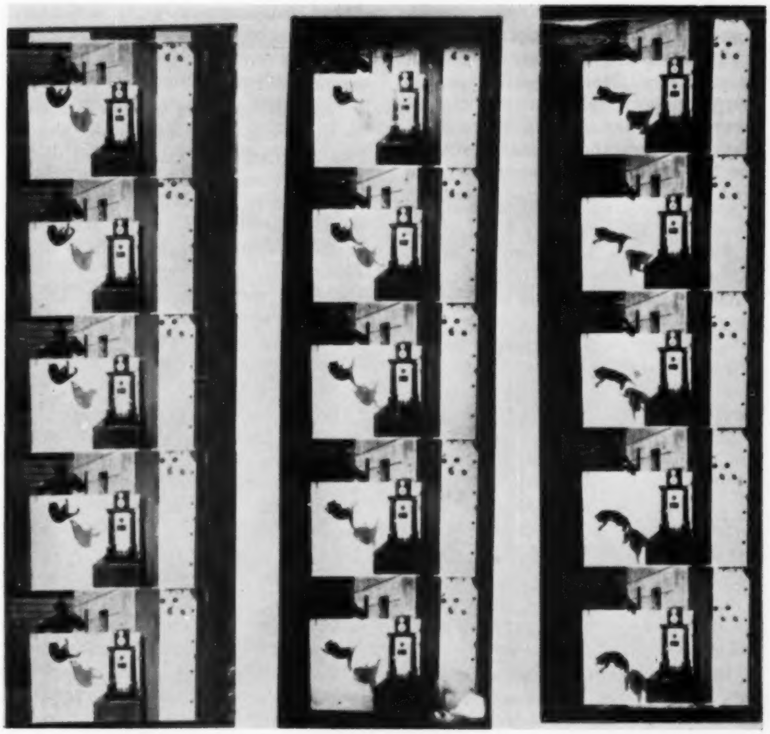


Fig. 14. Slow-motion pictures of falling cat (66 frames per second) beside millisecond watch by Hipp. Right: the shadowgraphs of two falling balls (iron and cork). (Camera developed by Messter 1897–1898.)

The aerial cameras developed by Messter were of special importance. When he received the order during the first world war, he immediately decided on using film. Until then glass plates were customary. The first construction, which was called in soldiers' slang "Strandhaubitze" (beach howitzer), used unperforated film 120-mm wide (4.724 in.). The pictures were 10 by 10 cm (4 by 4 in.), 250 frames on a roll 25 m (82-feet) long. A 300mm focal length Zeiss-Tessar was used as the objective.

The success of this camera resulted in an order from the German Army High Command for the manufacture of an automatic camera. It was used for the first time on May 26, 1915. It was called Reihenbildner (multiple picture camera), used unperforated 35mm film and the negative size was 3.5 by 24 cm (1.378 by 9.449 in.). The drive moved the film frame by frame in a horizontal direction. The camera was driven by a small air propeller. The objective was Zeiss-Tessar, focal length 250mm. The narrow strips, mounted properly, gave an uninterrupted image of the covered terrain. The ultimate camera used unperforated film, and the frames were 6 by 24 cm (2.362 by 9.449 in.). From 1915 to 1918 a total of 933,000 meters (3,061,017 ft) of film were exposed. For his process of taking small aerial pictures, photographed transverse to the direction of the flight and covering an area many times larger than the field of view in the direction of flight, and for his process of mounting the pictures, Messter received patents 298086, June 6, 1915; 300688, Aug. 25, 1915; and 301382, Jan. 28, 1916. The previously mentioned patents (331550, Mar. 21, 1918; 332273, Aug. 12, 1919; and 336649, Aug. 12, 1920) concern a continuously running film with alternatingly working optical compensation.

Another piece of equipment which Messter constructed during the first world war was designed to improve the marksmanship of machine-gunners. This camera was shaped like a machine-gun with identical sighting and identical hand controls. Instead of the bullet strip it was loaded with a film strip on which the target was recorded. In its center was a

cross-hair and a clock face. Each picture showed the location of the shot and the time. This instrument was built extensively and Messter received patents 309108, July 18, 1916; 309109, Oct. 6, 1916; and 317487, Apr. 13, 1917.

The Age of the Sound Film

Strictly speaking, the silent film was never silent, since the very first pictures were shown with accompanying music. Furthermore, many tried from the start to have synchronized sound and picture, using the phonograph method even though it gave mediocre quality and insufficient sound intensity. Only short films could be recorded with synchronized sound because in those days the running time of turntables and records was limited. When pictures increased in length, this first epoch of the short sound films ended and accompanying music gained more and more importance.

The first sound film epoch in Germany lasted from 1903 until 1913. A total of around 1500 sound negatives were made, with an average length of about 220 feet.

Oskar Messter deserves recognition in both sound recording and sound reproduction. Many patents and contemporary registered designs prove the manifold solutions of the problems. The main problem was the synchronization of picture and sound. Messter solved this first with electrical attachments. According to patent 154372, Apr. 9, 1903, the current went from a separately driven commutator to the motors of the phonograph and projector. Here he used one battery for both motors. In a supplementary patent, 155978, July 16, 1903, he employed one battery for each motor.

All these contrivances were tested by Messter in practice. It was found that, while the two motors ran completely synchronously, the slightest overload threw them out of phase and finally stopped them entirely. Consequently he finally used two direct-current series motors, with three collector rings, which were connected to corresponding armature windings. The three-phase alternating current generated in this manner served to maintain synchronous speeds since the armature windings of the two motors were connected through the collector brushes.

While this provided for synchronous operation of the two motors, line voltage variations or poorly spliced film passing through the projector mechanism caused speed variations, which in turn led to variations in pitch of the sound. Lacking better equipment Messter first accepted these disadvantages and demonstrated his "Kosmograph" on August 30, 1903 at the Apollo Theater in Berlin. It is possible that he used a synchronizing system described in patent 145780, Feb. 19, 1903, to couple the projector to a (master) drive-motor, while at the same time using an identical clutching device to couple the phonograph with its drive motor.

His sound pictures were well received by the public and the press and brought him contract engagements from variety houses at home and abroad. At the World Exposition in St. Louis in 1904 he also gave performances. Special films were taken in English such as *The Whistling Bowery Boy*. For 25 cents 5 to 6 films could be seen. The Biophon Theater there contained about 250 seats and on the average 500 tickets were sold daily. These sound films ran 20 frames per second.

While synchronization between picture and sound was faultless, the above-mentioned speed variations produced undesirable effects. Messter tried further approaches, in which synchronization could be controlled by optical or acoustical signal transmittance.

The film advance was first operated by means of a handcrank and later governed by a periodic bell or light signal, according to patent 177685, Sept. 8, 1903. This patent gained importance especially in the fight against competitors, who intended to reproduce this equipment, because it was simple and inexpensive. An improved version, with the addition of a Wheatstone bridge hookup and galvanometer, is the subject of patent 175905, Oct. 21, 1904, and the application of a differential drive with an auxiliary motor drive is part of patent 200469, Apr. 29, 1906. This synchronizing equipment, which was mechanically coupled to the projector, while the auxiliary motor of the gramophone was electrically controlled, became the most used instrument of the following years. By 1913 five hundred theaters installed Messter's synchronized sound projector equipment. He named it the Biophon and sold it on a license basis to Biophon Theaters.

The difficulties which one had to contend with in the phonograph industry, when one did not intend to use a certain playback method, are described in patent 237961, Dec. 8, 1910. To make a recording on a cylinder or disc, it was necessary to use a long funnel (horn) to obtain the greatest influence on the stylus. The unsightly horn had to be kept out of the picture. Patent 237961, Dec. 8, 1910 describes a large cabin with slanted glass plate to direct sound toward the horn, fastened to the roof of the cabin, which remains outside the field of the camera lens. This recording technique was especially necessary when big scenes were taken and when sound was recorded simultaneously. This method prevented the recording of camera noise on the phonograph disc. It is interesting that this approach is just the opposite of the present method, in which the noise of the camera is kept from the studio stage by enclosing the camera itself.

After the development of amplifying systems had made large gramophone records possible, Messter occupied himself again with the problem of synchronization. He obtained the following patents: 592478, Feb. 1, 1928; 561660, Feb. 23, 1929; 561661, Mar. 28, 1929; and 541791, June 8, 1929. They deal with an indicating and regulating device, mounted outside the projection room, a start marking device, the application of colored edge marking (to enable one, in case of film tear, to re-establish synchronization quickly in semi-dark rooms) and finally an automatic spring prewinding device to permit quick starting of gramophone tables.

When the picture *Submarine* by the Messtrofilm Exchange (a Messter subsidiary) was acquired in May, 1929, the sound was reproduced on his Messterphon, a disc instrument, connected mechanically to the projector and equipped for handling the normal 78 rpm and also the large 40-cm (15.748 in.) $33\frac{1}{3}$-rpm discs.

The era of the disc-films, which were the forerunners of the modern sound films, was short. The different carriers of picture and sound and consequently the differences in the necessary reproducing equipment, the limited life of the gramophone discs and the difficulty in case of film tear to re-establish synchronization, were the reasons why "needle sound film" gave way to the optical sound film. When this happened — about 1930 — Oskar Messter was 64 years old. Only two patents came out of this period: 545807, Oct. 24, 1929, which protects an optical printing method for sound recordings by the variable-area method; 702940, Nov. 25, 1930, granted to him jointly with Kurt Breusing, for a process where the picture is taken at a lesser speed than the sound and then through multiple printing steps the two recordings obtain equal length. Neither of these patents proved important.

Messter also occupied himself with the problem of post-synchronization. Patent 593277, Oct. 16, 1929, deals with a system whereby a text is projected in correspondence with the picture, which should aid the speaker or singer at post-synchronization. The patent specified that, in order to facilitate the synchronization with instantaneously projected pictures or reproduced sound, the corresponding word parts, such as letters, syllables, etc., were made especially apparent by changes in size, in boldness, density and other means.

The Musical Accompaniment

From the beginning motion pictures were shown with music accompaniment. The phonograph was replaced by a live

piano player. His duty was to adapt the music to the action.

When orchestras appeared and these, or a singer, were supposed to accompany the action, the picture had to be watched constantly by the conductor or the singer. To relieve them of this burden, Messter developed the Messtronom consisting of a line of music, running synchronously with the picture. In this manner only the music notes had to be watched (patent 293634, Aug. 13, 1913). Since the tape of the music moved at a constant speed, the writing had to differ from the normal type; according to the tempo the writing had to be more, or less, set apart. Of course, this process could be applied at the time of recording. This approach was tried by Messter in cooperation with the conductor and composer, Dr. Becce.

Later Messter decided to use pneumatically driven musical instruments, like the "Pianola," or "Phonola" (which became known about 1900), to insure agreement between subject matter on the screen and the accompanying music. Here the speed of the music tape changed together with the loudness of the music, when the pedals were pushed harder or gentler. To keep in tempo an additional hand lever had to be operated. To eliminate these disadvantages of the pneumatic drive, Messter added an auxiliary drive for the tape, obtained from an electric motor (patents 334585, Nov. 14, 1918; 334586, Jan. 21, 1920; 334587, Feb. 18, 1920; and 334588, March 11, 1920).

A little later Messter obtained patent 388509, June 18, 1922, which dealt with an improvement on the Messtronom. It was found that it was still burdensome for the conductor, and restrictive to his artistic talent, to watch the rolling music tape while he was also conducting. Messter's basic idea was that the conductor should not be governed by the projector, but that the projection should follow the conductor. The patent provides that a type of steering arrangement, connected to the projector, should be hand-operated by one of the musicians, who follows the conductor. Different possibilities were listed in the patent.

To enable one speaker to be heard during the showing of a film simultaneously in different theaters, which also may be in different cities, good synchronization was needed. Messter developed for this purpose the "Chronomesster," a clock with a second hand, making two revolutions per minute. On the outside of the clock two additional hands were located. These hands were coupled to the projector by means of a flexible shaft. The projector was adjusted in such a way that the position of one hand always corresponded with the second hand of the timer. Text or music could then be transmitted by radio. On Oct. 29, 1929, Messter showed in Berlin at the meeting of the Deutsche Kinotechnische Gesellschaft that the two systems (Chronomesster and Messtronom) worked.

Finally, Messter's Conductor-Films should be mentioned. The goal was that of having the orchestra conducted by projecting the motion picture of the conductor. He aimed to obtain the same effect a living conductor achieves and with this invention he planned to preserve the art of famous conductors for posterity. Patent 293573, Nov. 4, 1913, provides for a specialized piece of projection equipment, showing the conductor to the orchestra members from the front and to the audience from the back. The two views can either be taken with two cameras, or according to patent 324057, June 12, 1919, with a single camera and mirrors on a single strip of film. Messter himself operated with the latter scheme as early as 1913. Projection was done on a split screen. On the lower, opaque half, the orchestra sees the conductor from the front; on the upper half of the screen (which is transparent) the audience sees the conductor from the back. One of the pictures has to be taken with a mirror so that the image does not appear reversed left and right. This rearrangement is protected by patent 327228, Aug. 12, 1919. Messter photographed a number of leading conductors by this process.

Fig. 15. Oskar Messter medal, established by the Deutsche Kinotechnische Gesellschaft, Nov. 23, 1926; first bestowed on Oskar Messter, Dec. 1, 1927.

While this type of conductor film did not achieve general acceptance, it was a lasting contribution by Oskar Messter toward preserving the appearance and art of famous conductors. These films are preserved as priceless music historical documents at the German Museum in Munich.

The Importance of Oskar Messter in Connection With the Motion-Picture Industry

So far we have discussed only Messter's merits in the technological field. His biography would be left incomplete by failure to mention his importance in the German film economy. He was founder of the German motion-picture equipment industry since he manufactured all the necessary equipment for picture taking, processing and printing; however, he occupied himself also as producer and theater manager and was the founder of the German film trade.

His first movie catalog printed in October, 1897, and published in 1898, listed no less than 84 self-produced films. These were studio and location shots, scientific and technical films, also news shots, which have since obtained great historical value as documentary films. In 1898 he equipped, with his own funds, a film expedition, and as his own camera man took pictures in Turkey, Palestine and Egypt. When in 1896 Messter started to make entertainment films, he was author, director, operator, processor, printer and projectionist, all in one. In 1897 he made his first close-ups. The title of the picture was *From Seriousness to Laughter* (No. 4 in the Messter listing). His first trick film was *Rapid Painter Clown Jigg* (No. 5 in Messter's catalog). He took the scene at a slower speed and projected it at normal speed to increase the impression of the speed at which the painter worked. He produced the first German time-lapse picture. His film taken in 1897 with a lapse factor of 1500 frames per 24 hours, showing the blooming and wilting of a flower, can be considered the first German documentary. When in 1910 the longer entertainment pictures appeared, he employed artists for scripting, directing and acting, but he reserved for himself the planning, casting and the production of the film.

In 1901 he founded the Projektion GmbH when he changed in 1902 to "Messter's Projection GmbH." This firm, which was not dissolved until 1930, produced all his pictures prior to 1913. He founded — also in 1901 — the Kosmograph Compagnie GmbH which specialized in the manufacture, professional demonstration and display of equipment.

The Kosmograph concern was converted into Messter Film GmbH in 1913 and assumed the production of the Messter films. All these restricted liability companies (GmbH), to which (in 1913) he added the Author-Film Co., operated with independent capital structures. The *Messter Week*, a weekly newsreel which became famous through its truthful news reporting, was started Oct. 1, 1914. The old trademark of the Messter films, the globe rotated by a strip of film, became a familiar sight abroad. On Jan. 1, 1920, the *Messter Week* was taken over by the *Deulig-Week*. Messter also owned theaters. His first was at 21 Unter den Linden, and the last (in 1913) was the Mozart Hall. This was absorbed in 1917, together with the Messter Film GmbH, the Author-Film and other companies by the newly founded Universum Film Co., Ltd. (UFA).

Messter was also one of the founders of the Tonbild-Syndikat A. G. (Tobis) in 1928, a merger of his company, Triergon, Küchenmeister and Deutsche Tonfilm A. G.

Oskar Messter was mostly interested in films of literary or historical background but he did produce some comedies, thrillers and serials. Well-known technicians, cameramen and directors were his pupils and are indebted to him for the thorough education which was responsible for their later successes. Nearly all great actors and actresses worked with Messter and many of those who were discovered by him reached stardom. Henny Porten should be mentioned especially. At a very young age she became a world-famous star, the first one in Germany. Authors and musicians were among Messter's friends, because they felt that he tried to reproduce their work to the utmost perfection.

The Deutsche Kinotechnische Gesellschaft honored him on Nov. 23, 1926, by establishing the Oskar Messter medal, which is given to outstanding promoters of cinematography. He was made the recipient of the first medal on his sixtieth birthday (Fig. 15). On Nov. 26, 1936, the Technical University, Berlin, granted him the title of honorary senator, in recognition of his services to university education. The German Museum in Munich appointed him a life member of its committee and bestowed on him the golden museum ring.

He died on Dec. 6, 1943, on his estate at Leitenbauernhof on Tegern Lake. His last patent, granted when he was 72 (717925, Feb. 27, 1940) was for a film stopwatch. It probably is the smallest item he ever built. It is not a normal stopwatch, which has a meter scale added to the face, but a watch on which film has priority over time. One complete revolution of the hand does not equal 60 seconds but 10 or 100 meters. Beyond all, this watch stands as a symbol of Oskar Messter. In Messter's life, as on this watch, time and film are inseparably connected.

Acknowledgments

The present work is based chiefly on Messter's autobiography: *Mein Weg mit dem Film*, (*My Way With the Film*), Berlin, 1936, and on his patents and registered designs (*Gebrauchsmuster*).

The author is grateful to Oskar Messter's widow, Mrs. Antonie Messter, for the material from the Oskar Messter Archives; to Director L. Henning and Inspector R. Reitberger for furnishing items about the exhibit and in the storage of the German Museum in Munich; for several investigations of patent rights to Dipl. Ing. A. Essel, patent attorney and chief of the patent department of Siemens and Halske A. G., Munich, and to Dr. H. Atorf, senior government councillor at the Berlin branch of the German Patent Administration, for several legal patent investigations and helpful suggestions.

Much additional information was furnished by Gerhard Lamprecht, member of the "Comité Directeur du Bureau International de la Recherche Historique Cinematographique."

Ed. Note: See Biographical Note (*p. 771 of this issue of the* Journal) *about the contributor of this article.*

Effective Spot Size in Beam Scanning Tubes

By AURELIUS SANDOR

The Gaussian current distribution does not hold in practical electron beams because of aberrations, space-charge and masking conditions. Only an overall effect of the total current is useful for defining spot size; and thus, the observation of the visible spot boundaries on phosphor screens is adopted (telescope). Because of the prevailing bell-shaped current density distributions, this definition comes closest to a practical measure of spot size based on center peak brightness. Experimental evidence is given for the formation of vertically reduced spot sizes during beam scanning in form of ellipses, manifesting itself in a significant improvement on vertical picture resolution.

A MATHEMATICAL ANALYSIS of the current density ρ in a stationary beam spot shows that a Gaussian distribution must hold in radial direction r of the type

$$\rho = \rho_0 \cdot e^{-Kr^2} = \rho_0 \cdot e^{-K(x^2+y^2)}$$

with ρ_0 being the center peak density in the case of a solid, circle-shaped beam cross-section. However, this condition is restricted to the ideal (impractical) case when no space-charge and no optical aberrations enter the problem. In practice, the iris effect, which consists of a size change of the effective emitting cathode area during intensity modulation, leads to varying spherical aberration. Aberrations and space-charge alter the current distribution to a very appreciable degree. If a beam-intercepting aperture stop is used, a further departure from the Gaussian function occurs. Generally, a "bell-shaped" current distribution with a flattened peak will prevail. However, it cannot stay constant either along the beam because of the discrete location of the electrodes causing the aberrations. Since the Gaussian concept must be dropped for all practical purposes, certain advantageous characteristics of that function related to spot size definitions and measuring methods have to be abandoned as well.

Aided by Fig. 1, the Gaussian case can be expressed by

$$\frac{\sum_{-\infty}^{+\infty} \rho x_1}{\sum_{-\infty}^{+\infty} \rho x_0} = \frac{\rho x_1}{\rho x_0} = e^{-Kx_1^2}.$$

In other words, a realistic spot size definition could be linked directly to the spot diameter by knowing (measuring) the ratio of integrated function values along parallel chords (slits) instead of points along the diameter. If the Gaussian distribution does not hold, no relation to the true current distribution can be established, particularly, if comparison with spot sizes of different origin is intended (different gun elements).

A contribution submitted on March 7, 1960, by Aurelius Sandor, General Telephone & Electronics Laboratories, Inc., Bayside 60, N.Y. (Final manuscript received August 9, 1960.)

Definitions of Stationary Spot Size

Spot size, no matter what definition is selected, has to be related to the degree of radial decay of current densities or of their physical effect. To express the spot boundary (current density ρ_b) in terms of a ratio figure with respect to the center peak density ρ_0 is most obvious,

$$\rho_b/\rho_0 = X. \tag{1}$$

A measuring technique of this kind, however, poses difficult mechanical problems since the probe (Faraday cage, photometer aperture, etc.) has to pass with high accuracy through the center of the often microscopic spot. Hence, the next best approach is to utilize the signal enlarging and integrating properties of a slit arrangement. A slow steady sweep of the spot normal to the stationary measuring slit delivers a set of readings on the collector plate with one of them necessarily belonging to the true spot diameter (maximum). A synchronously writing oscilloscope can then record the output and display a more or less bell-shaped current distribution.[1] An arbitrarily small value X, as expressed by Eq. (1), but now in terms of currents, will then set a boundary condition for a practical spot size.

Any nonlinear dependence of fluorescent light output from phosphor screens or of other secondary response effects to the primary beam, as well as beam geometry, current distribution, writing velocity and background illumination, will modify the final spot size. Since a simple correlation to the true current distribution in the beam does not exist, any definition of spot size is acceptable which expresses same directly in terms of the ultimate display effect (brightness, charge density, opacity, etc.).

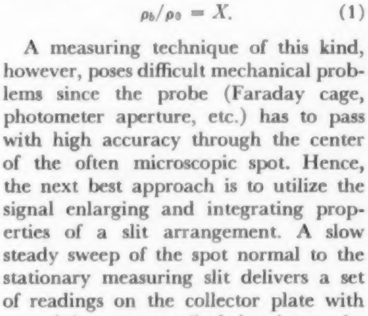


Fig. 1. To Gaussian current distribution in the stationary spot.

Visual Measurement of Spot Size

A spot size definition was chosen which is readily obtained from visual observations on the luminous phosphor screen. No special vacuum techniques and complicated instrumentation are required. A cathetometer equipped with a reasonably magnifying telescope sight (6 to 7 times) and vernier reading is satisfactory.

The reading is based upon the relative sensitivity of the eye to brightness contrast which was found to have a range between the center peak brightness B_p in the spot down to about 5% of it. Beyond this 5% value there is no light sensation against an objectively dark background as long as the maximum brightness is present nearby. Aiming the cross hair of the telescope at the just discernable edge of a small luminescent spot will then automatically determine the so defined spot boundary. The smallness of the viewing angle is overcome by the moderate magnification so that instead of brightness integration the center brightness becomes the reference. This definition results in spot size values much larger than obtained by any other proposed method, but has more physical meaning.

For stationary spot measurements it is necessary to use pulsed beams in order to avoid phosphor burn. Aluminized screens are preferred because of better heat conduction and for avoiding spot jitter by phosphor charging effects. With 1 to 2 milliamperes in the spot, a duty cycle of 0.01% is safe enough and can be made larger for smaller currents. It is actually the peak current in the pulse that counts, independent of the current transitions with time, for the spot assumes its largest size at the highest instantaneous current value.

The investigator will quickly find out that the sometimes disturbing light scatter in the phosphor and some electron back scatter at higher beam currents produce a fairly sharp demarkation line between the actual beam effect and the light-optical side effects surrounding the spot. Lowering the duty cycle improves the situation by reducing the overall intensities.

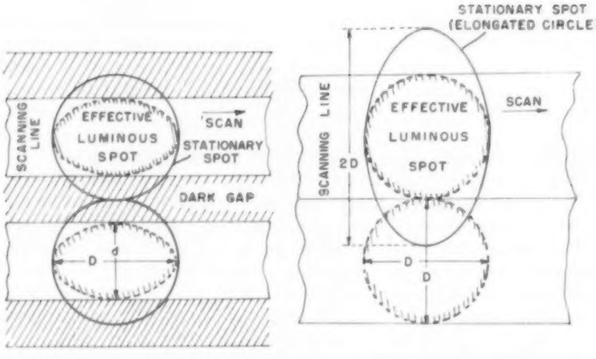


Fig. 2. Effective spot size formation during scan. Left, round starting spot; right, elliptic starting spot.

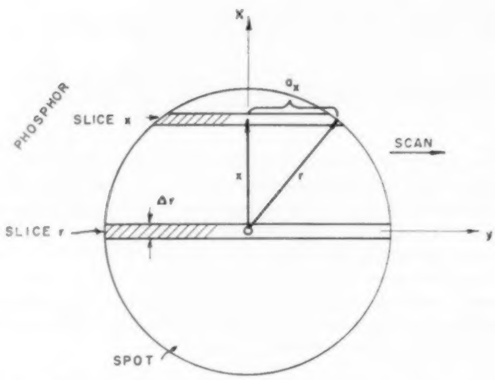


Fig. 3. To brightness analysis in the scanning spot.

The Situation in Scanning Tubes

The spot size which writes the picture in a television tube is decisive regarding picture resolution, provided that the transmission and the receiving system pass enough information detail. The problem becomes more severe if a three-component color display is considered where the spot size becomes only about $\frac{1}{3}$ of the monochrome spot. For the same picture resolving quality, three independently operating color elements (simultaneous or sequential) have to fill in. Regarding picture resolution, the dynamics of the scanning spot produces much more favorable results than could be expected from the resting spot.[3] This is particularly true with color tubes as there are severe limitations to a reduction of the primary or resting spot size by gun optics.

Viewing a television picture from close up, one can clearly distinguish between bright and black lines. The question seems obvious: why tolerate the presence of 485 dark lines if a vertical picture size reduction could easily remove them? However, by shrinking down the picture height, a very disturbing loss of horizontal picture detail occurs whereas the vertical resolution still seems satisfactory. It was assumed here that the horizontal picture width was automatically (proportionally) reduced with the vertical size in order to maintain true picture geometry. Figure 2 visualizes this situation. Such differential resolution is only possible if the luminous spot became an ellipse with its minor axis normal to the direction of scan and its unchanged major axis parallel to it. In contrast, the undeflected luminous spot of perfect circle shape fits exactly into the predetermined line raster spacings of television screens without leaving any dark gaps.

Another proof for the formation of an elliptic spot is the beneficial effect of the spot oscillation or wobble technique on vertical picture resolution or, as an alternative, of the stationary spot elongation normal to the scan by using a constant magnetic deflection field near the deflection yoke. With both methods the dark gap pattern was removed without having impeded the horizontal picture resolution. Figure 2 shows the case of the static spot elongation. The stationary spot, pre-elongated into a vertically oriented ellipse, was restored again to an effective circle shape by scanning. In order to take advantage of such vertical spot size reduction, the raster line frequency and the modulation band had to be broadened (approximately doubled) in accordance with the spot compression.

Dynamic Spot Formation During Scan

Because of the physiological property of the human eye to store light sensations (persistence of vision), a certain minimum number of modulated line rasters, supported by interlacing (picture frame), can be presented per second on a luminous screen without impairing the sensation of continuity of motion.

From the required number of frames per second, corresponding to the optimum storing time of the eye, one can calculate the length of the luminous line trace l_{st} left behind on the retina when virtually projected back onto the true screen scale. A physical meaning is given to l_{st} by the fact that with zero brightness at the start and full brightness at its termination, as well as for a constant beam current,

$$l_{st} = v_{st} \cdot t_{st} \qquad (2)$$

where v_{st} stands for the eye-matched scanning velocity and t_{st} for the corresponding scanning time required to write l_{st} before return to frame start. The storing effect is usually supported further by a phosphor response with matched brightness decay equal to the storing time t_{st} of the eye for one frame.

Talbot's law,

$$B_{x(\mathrm{av})} = \frac{1}{t_{st}} \cdot \int_0^{t_{st}} B_x \cdot dt$$

determines the average brightness $B_{x(\mathrm{av})}$ of any scanning slice x (stationary spot) at the level x in the line trace l_{st}.

Assuming a circle-shaped stationary spot of uniform diametrical brightness distribution (Fig. 3), the objective brightness ratio of the scanned total slice length sx in the line trace to the brightness of the stationary slice x will be, since the spot (slice) was stretched into the length l_{st} and brightness is a linear inverse function of the stretching length (all B_x-values are Talbot averages),

$$\frac{B_{sx}}{B_x} = \frac{2a_x}{l_{st}}. \qquad (3)$$

Similarly, the brightness ratio of the scanning center slice to that of the stationary slice $2r$ is

$$\frac{B_{sr}}{B_r} = \frac{2r}{l_{st}}. \qquad (4)$$

Hence, the brightness ratio of any level x in the sweep trace to the center sweep follows from Eqs. (3) and (4),

$$\frac{B_{sx}}{B_{sr}} = \frac{a_x}{r} \cdot \frac{B_x}{B_r}.$$

As for the circle-shaped spot with uniform brightness distribution,

$$\frac{B_x}{B_r} = \frac{a_x}{r} = \sqrt{1 - \frac{x^2}{r^2}},$$

thus

$$\frac{B_{sx}}{B_{sr}} = 1 - \frac{x^2}{r^2}. \qquad (5)$$

The average objective brightness of any trace level x becomes therefore

$$B_{sx} = B_{sr} \cdot \left(1 - \frac{x^2}{r^2}\right)$$

or, with (4) and (2)

$$B_{sx} = \frac{B_r \cdot 2r}{v_{st} \cdot t_{st}} \cdot \left(1 - \frac{x^2}{r^2}\right) \qquad (6)$$

which allows the calculation of the dynamic or stored brightness of any trace level normal to the sweep from the data of the resting round spot. This function shows that the luminous trace does not maintain vertically the same relative brightness values as the resting spot, meaning that a vertical compression took place to form a virtual ellipse as a trace element with its major axis in the horizontal center line of the trace unchanged and equal to the stationary spot

diameter. Since flicker-free viewing was one of the premises, the factor t_{st} (frame time) in Eq. (6) stays always constant. Because of this necessity the ellipse cannot change its proportions based on brightness criteria alone, not even if larger pictures (higher v_{st}) are to be displayed while still assuming a linear phosphor response. What changes then is not the line width but the brightness factor which stays constant for all horizontal zones in the trace because of the general, proportional loss in brightness at increased velocities.

If the brightness distribution across the round luminous spot is nonuniform and, as is usually the case, takes a bell-shaped form such as $f(x^2 + y^2)$ for instance, then a much steeper decay of brightness will occur towards the spot edge, resulting in an accordingly shorter minor axis of the dynamic elliptic spot or a narrower scanning line width.

Line Width and Phosphor Response

When increasing the writing velocity, as might happen with an expanded picture size, an additional gain in vertical spot size reduction will follow based on the actually nonlinear brightness response of all practical phosphors. Of particular interest are those with a medium long rise time and persistence, as required for eye-matched and flicker-free reproduction of motion. Figure 4 is helpful in explaining the phenomenon.

On the left side a round stationary spot sweeps horizontally with the velocity v. A vertical channel in front of it is used with a horizontal slit aperture sliding in it for localizing the objective brightness from each spot slice (photocell). The shorter slice 1 sweeps in a shorter time t_1 across the channel than the longer slice 2 which takes the time t_2.

On the right side the scanning speed is increased to $n \cdot v$. Correspondingly, slice 1 will stay for t_1/n seconds in the slit and slice 2 for t_2/n seconds. According to the differential slope of the nonlinear phosphor response curve, variable brightness differences will develop between each two slices, that is ΔB_v versus ΔB_{nv}. The brightness distribution across the dynamic spot (scanning line width) will vary accordingly with the result that for the higher scanning velocity a relatively slimmer distribution curve follows. This means that the 5%-of-peak marks chosen for spot boundary definition are pushed inwards. In other words, the height of the dynamic luminous spot or the scanning line width d_v is reduced to d_{nv} at higher velocities. However, the brightness of all levels in the line loses in absolute value besides, because of the increased speed. Except for the uniform current distribution in the beam, the size of the resting spot will be also subject to variation because of the nonlinear phosphor excitation with current density with a general trend toward larger spot sizes as compared to phosphors with a linear response.

It is interesting to conclude further that a short-rise-time and therefore a short-persistence phosphor is beneficial for a pronounced vertical spot size reduction (except for flicker) even without increasing the scanning velocity as becomes evident if the shown phosphor response is replaced by a steeper one.

Spot Size and Background Light

Background illumination on the screen may have different sources, internal and external ones. In the upper part of Fig. 5 an arbitrary brightness distribution is assumed across the luminous scanning trace in the absence of background illumination. The dynamic spot size is now d, while it becomes apparently narrower (d_b) in the lower figure where a constant ambient brightness B_0 prevails which was added to all points of the brightness distribution. Now, since the peak brightness was raised to $B_{max} + B_0$, the 5% spot boundary mark became larger and had to be raised above B_0 for visible distinction of contrast against this extending background reference B_0. This brings the apparent spot boundaries closer together to form a smaller vertical spot size or line width until, at high enough B_0, the entire luminous line is extinguished. The resting spot is affected in a similar manner.

This condition appears on any television screen if external light is thrown onto it. One judges now against a preset background level that overlaps and apparently narrows the base of the distribution curve where it is the broadest. Contrast, on the other hand, will become poorer. This is why spot size definition, if not based on the black sensation

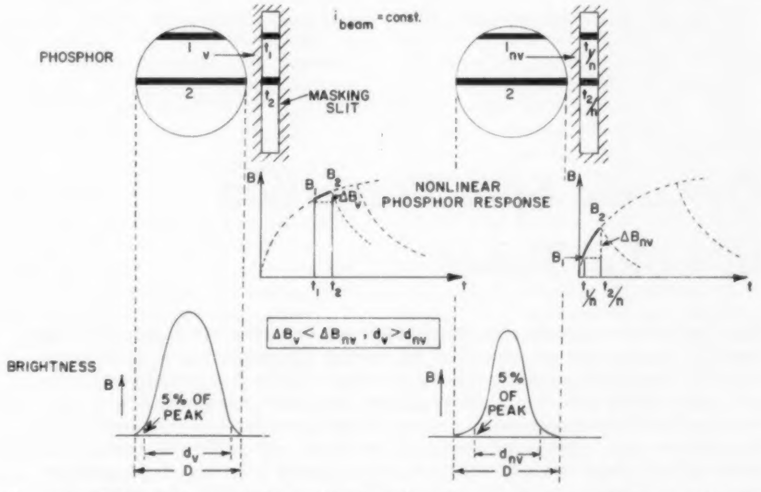


Fig. 4. Variation of line width d_v with changing beam deflection velocity v and nonlinear phosphor response B = f(t).

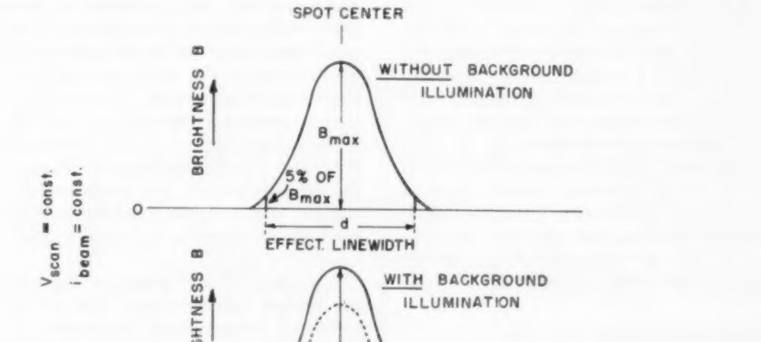


Fig. 5. Line width d versus background illumination B_0.

of the eye, may become a very confusing and unrealistic matter.

Intimately connected with the background effect is the subjectivity of the well-known Shrinking Raster Method for line width measurement. The open raster is shrunk down by means of the vertical raster height adjustment until the apparent boundaries of the bright line traces just begin to merge (telescopic viewing). From the number of lines and the height of the shrunken raster the so-called "line width" follows. However, as the trace boundaries approach each other, the marginal brightness areas of neighboring traces will overlap, producing a composite background level which is about twice that associated with a single trace. Additional background light due to reflections leads, at the expense of adequate contrast, to the misconcept of a strongly reduced luminous trace or spot size.

Conclusions

It was shown how the vertical extension of the dynamic spot may acquire values of the order of less than one third of its stationary value. The slimmer the bell-shaped current distribution curve within the resting beam or the brightness distribution in the resting luminous spot is, the larger is the gain on the dynamic size during beam scanning. A change in size also occurs when the scanning velocity is varied in combination with a nonlinear phosphor response. When changed to another characteristic, a vertical size variation, even at constant scanning velocities will occur. The velocity factor is of less importance with standard picture transmission, except for the velocity-wise still open radar methods or in high-speed transmission systems connected with signal storage for read-out.

Vertical spot size reduction is real only in connection with beam scanning and with display or indicator elements of storing property capable of integrating energies over time such as photons for brightness, electrons for charges, crystal opacities for light effects, density of photographic emulsions, etc. A sweeping spot that could be followed with the eye, which is equivalent to the elimination of the persistence effects of vision by synchronized motion, would appear as an immobilized and therefore unchanged round spot.

Marginal background lights will lead to apparently undersized stationary and dynamic spot sizes. The widely used Shrinking Raster Method for determining line widths is therefore of little objective value. The optical measurement on single line traces still constitutes the most practical, least subjective and quickest method when referring to the visible contrast limit of spot or line boundaries.

References

1. L. Jacob, "Electron distribution in electron-optically focused electron beams," *Phil. Mag.*, July, 1939.
2. Aurelius Sandor, "Dynamic spot formation in color tubes," *Jour. SMPTE, 69:* 738–742, Oct. 1960.

Dynamic Spot Formation in Color Tubes

By AURELIUS SANDOR

Based on a former investigation, the dynamic spot formation and its size-reducing property during scan are visualized for square- and circle-shaped beam spots. While the feedback-type color tube systems require *a priori* an extremely small spot, the grid-focusing and the masking systems can utilize conventional spot sizes because of additional short-range focusing facilities and beam-shaping external to the electron gun. Alternative modes of operation with different scan-to-grid relations in the Lawrence color tube system are critically investigated. An optimum spot size condition is found when operated with wire-parallel scan and with a high grid-deflection rate which also removes the moiré effect.

The indexing spot of feedback-type color tube systems also incurs a horizontal spot size reduction, alleviating the problems of a primary narrow spot formation. This is due to the gradually overlapping area of spot and indexing stripe, the signal output of which can be arbitrarily cut to match the activation threshold of the detection circuit. Such a horizontal mechanism, combined with the dynamic vertical reduction, can lead to a spot size reduction of two thirds, or less, eventually approaching a circle.

Beam and Dynamic Spot Size

There are color tube systems in which spot size is more critical than in others. These are the so-called indexing type tubes which depend primarily on a very small spot size for signal generation, used to control the actual writing spot, and secondly on a small, intensity-modulated spot used for picture writing. Unlike these tubes, the shadow-mask tubes and the grid-focusing systems solve the necessary small spot condition outside the gun by beam-masking or close-range focusing of the oversized primary spot.

Assuming a linear phosphor response, the resting luminous spot will always be a true (proportional) brightness replica of the current pattern in the resting beam spot. It will be found, however, that beam-scanning significantly changes this relation,[1] and the decisive factors are:

(1) spot motion,

(2) storing properties of phosphor and eye,

(3) shape of current distribution in the beam,

(4) geometry of leading and rear edge of the beam spot normal to the direction of scan,

(5) nonlinear phosphor response combined with change of scanning velocity, and

(6) change of nonlinear phosphor response at constant scanning velocity.

In Fig. 1, the relations indicated in "*a*" to "*d*" will become qualitatively clear, starting with a square-shaped beam spot of uniform current distribution. During sweep, it again produces a square-shaped luminous spot of the same side lengths (D) and with uniform, but lesser, brightness (B), or charge equivalent (Q), anticipating the possibility of a capacitive recording instead of the luminous response, as in storage tubes. Another alternative would be the utilization of photographic densities or of crystal opacity for signal recording, as displayed in dark-trace tubes. The mechanism of spot formation will be discussed in another article.[1] All factors in this case being constant, the brightness or charge induced in each elementary slice "*a*" will also be constant.

In the second diagram, where for both axes of the square spot an arbitrary,

A contribution submitted on March 3, 1960, by Aurelius Sandor, Physical Electronics Lab., General Telephone & Electronics Laboratories, Inc., Bayside 60, N.Y.
(Final version received on September 28, 1960.)

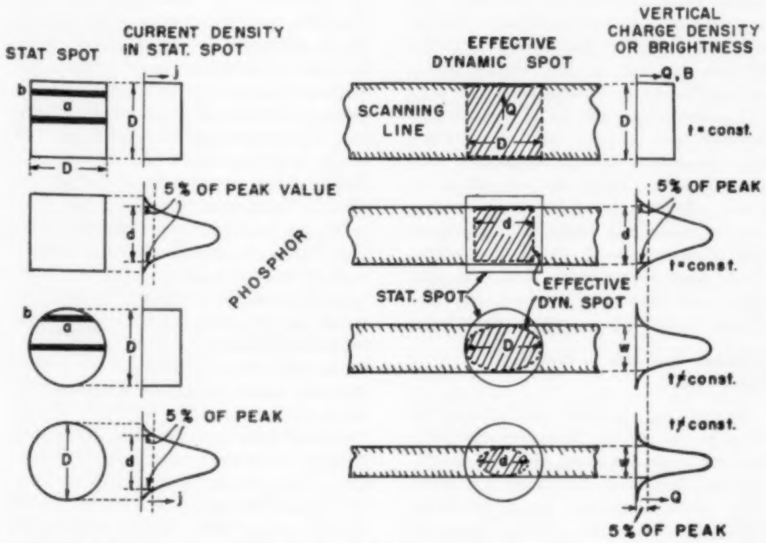


Fig. 1. Stationary spot and scanning line width.

though bell-shaped, current distribution was assumed, the sweep velocity causes different horizontal slices to set up different integrated charges or brightnesses along the sweep paths as measured through a vertical slit. From the resulting vertical distribution (Q, B) in the dynamic spot, the spot size within the arbitrarily defined, but physically meaningful, 5%-of-peak boundaries[1] can be determined. Since in this case the same distribution holds in both directions, the spot size will be equally reduced to form a smaller square spot of the width "d". However, this reduction also occurs in the resting spot and is based, therefore, on the former boundary definition, while the dynamic reduction is zero, since the leading and rear spot boundaries are straight and perpendicular to the sweep direction.

The dynamic behavior of a spot generated by a round beam spot with uniform current distribution differs. Because of the circle-shaped spot boundary, each sweeping horizontal slice "a" sets up a different integrated charge or brightness as shown by the third diagram (Fig. 1), producing, under a vertical masking slit, a final vertical distribution of distinct bell shape, resulting in a vertical spot size reduction down to "w" within the 5%-of-peak boundaries. The horizontal spot extension remains unchanged (D). The dynamic spot, therefore, assumes the shape of an ellipse.

In the fourth diagram (Fig. 1), a bell-shaped current distribution was again elected in the round beam spot. A starting constriction within the 5%-of-peak boundaries is obvious. Under sweep action the bell-shaped current distribution further changes into a slimmer, stored distribution pattern, pulling the spot boundaries closer together (line width "w"). The horizontal extension of the dynamic spot, however, maintains the diameter of the stationary spot (d) to the extent of the definition of spot size here used (5%-of-peak).

Dynamic Spot Size in Non-Feedback Color Tubes

In spite of a moving spot, situations do exist where no spot size reduction occurs. But this apparent contradiction can easily be resolved by looking into the various spot motion mechanisms.

Figure 2 illustrates the focusing action in the single-gun, grid-focusing and grid-color-switching tube, known as the (original) Lawrence tube. Another version, with three guns, developed by General Electric Co., uses parallactic color selection in place of grid-color-switching. These tubes employ the same focusing principle. Focusing occurs by post-acceleration by means of electrostatic cylinder lenses displayed between parallel wires and the conductive screen. Sharply refracting equipotential surfaces between the wires compress the primary spot to a width of about 0.004 in. This strong lensing effect acts normal to the wires because of the two-dimensional fields, shown at right.

In the wire-crossing scan (vertical grid wire array, horizontal scan), when operated in the original Lawrence tube, a major spot size reduction will accompany focusing, causing a gain in horizontal resolution. The longer, vertical axis of the resultant spot may, however, also be compressed to less than $\frac{1}{3}$ of its length. No further vertical spot reduction occurs in the non-grid-color-switching arrangement, where reduction takes place horizontally.

The explanation is simple. In one instance additional horizontal sweep over the phosphor occurs, while in the other there is no motion.

It is essential to realize that in the original Lawrence tube the beam is swept around between the wires for color selection at a very high speed of 3.58 mc/sec, according to NTSC* standards, and never comes to a rest, except at the points of motion reversal on the extreme stripes of each color phosphor triplet behind each wire track. Its mean velocity, therefore, is much higher than the slow primary scanning velocity of the beam in front of the grid wires. Vertical spot size reduction should therefore be much greater than that of standard television scanning velocities, as becomes evident from the relation to the nonlinear response of practical phosphors.[1] Thus, the writing spot acquires quite a small dynamic or visible spot size that tends to approach a uniform extension in both vertical and horizontal directions.

Since the extreme ends of the short oscillation amplitudes (3.58 mc/sec) in the two extreme stripes of a color phosphor triplet occupy but a small portion of the total swing, the size averaging effect statistically will favor the smaller spot size. The fact that a sharply

* National Television Standards Committee.

Fig. 2. Close-range beam focusing in the Lawrence Color Tube System.

pre-elongated elliptical spot with a steep leading edge sweeps back and forth in each wire track makes the vertical spot size reduction less effective than that of a round spot. Conversely, no continuous motion is, or can be, imparted to the spot in the non-grid-switching type due to the peculiarity of the lensing effect between unipotential wires, which causes the focal spot to stand still, within and beyond any two adjacent wires, while the primary beam is uniformly scanning in front of them. The slow but continuous frontal scan thus is converted into a fast, discontinuous, jumping action from wire track to wire track, that comes close to the resting phase of the spot and which cannot, therefore, produce any vertical size reduction because of a lack of continuous horizontal motion on the phosphor stripes. Hence, the vertical resolution will be inferior to that in the grid-color-switching (original Lawrence) tube; also, a smaller primary beam diameter is required in front of the grid. This tube benefits even less vertically from scanning than do regular black-and-white picture tubes.

It is known that the wire orientation of both Lawrence systems can be turned around by 90° (primary scanning motion parallel to the horizontal wires). As will be explained, both tubes will perform almost, but not quite, equally well. In the original Lawrence system, the final spot sweeps fast back and forth in each wire track normal to the wires (vertical motion); it performs, in addition, the conventional horizontal writing motion. While the first action improves the horizontal resolution by reducing the longer horizontal portions of the vertically compressed focal ellipse, the second action shortens the vertical spot axis still further. The non-grid-switching system, when operated with wire-parallel scan, does not receive the benefit of spot size reduction in horizontal direction since motion normal to the wires is absent. Its gain on the vertical axis is insignificant after a sharp permanent reduction to about 0.004 in., obtained by the constant, non-dynamic post-focusing lensing effect between wires.

One may conclude, from the foregoing, that the original Lawrence tube, with its high grid-deflection rate, if operated with wire-parallel scan, represents the best compromise in relation to overall picture resolution, both vertically and horizontally. The fast up-and-down sweep within the wire tracks, leaving behind a multitude of sinusoidal paths, provides the means for extinguishing the dark separations between primary scanning lines analogous to the spot-wobble technique used in certain black-and-white tubes. The optical interference or beat pattern effect (moiré) which almost invariably accompanies line rasters with superimposed line scan also is removed by this high-speed grid-deflection, leaving an interwoven chain pattern between scanning lines.

The above spot size considerations are decisive with respect to color purity. But for adequate overall picture resolution, with regard to size of composite picture elements, it is necessary to provide a fairly small primary spot diameter in front of the wires, as the spot covers more than one wire track and tends to produce multiple (however color-true), spots on the screen.

Dynamic Spot Size in Feedback Color Tubes

Several old concepts of beam guidance at the screen have recently been revived and one was applied to the "Apple" System of the Philco Corporation. These concepts, based on feedback signals for color control generated back from the screen (indexing stripe) are released either by the writing beam itself, or by an auxiliary beam (indexing beam) that precedes or accompanies (vertical displacement) the actual writing beam. As the indexing spot crosses the indexing stripe, a signal is generated as Fig. 3 shows. The indexing stripe can be a secondary emitter, a source of visible or invisible radiation, or simply a conducting stripe. In a radiated impulse, the signal is picked up and converted to current, then fed back into the gun circuits to control the color congruency on the color phosphor stripes (triplets) in accordance with the components of the color transmission signal.

While the low-current indexing spot does not pose serious problems concerning size and cathode life, the writing spot does. No means external to the gun are provided for matching the spot diameter with the narrow color stripes, as is achieved by masking or post-focusing in the other color systems. To obtain adequate spot sizes with the usual writing currents, the control grid aperture of conventional gun structures has to be further constricted,[2] causing the oxide cathode to suffer severe damage by excessive field strengths and its life span to fall far below the commercially tolerable limit.[3] It thus becomes necessary to investigate the possibilities of secondary spot size determining factors, external to the gun, to aid the realization of indexing systems.

Dynamic size reduction of the indexing spot must be linked to storage or integrating properties of the indexing means for gain to occur. Since secondary electron emitters do not have this property, visible or invisible radiations from phosphors, induced by electron bombardment, again have to be employed. Charging effects of proper time constants, or even crystal opacity effects, may also be utilized.

In phosphor radiations of different wavelengths — assuming a storage time, after excitation, close to the traversing time of the indexing beam spot — a vertical size reduction of the signal radiating spot trace is obtained.[1] Colorwise, this dimension is of little importance with horizontal scan and vertical indexing stripes. It might, however, be of some significance where vertical resolution of the indexing pattern is an objective. Only indexing materials or methods with storing properties will be considered.

Because of vertical spot size reduction it now appears that the use of horizontally arranged color stripes is preferable. However, this would necessitate

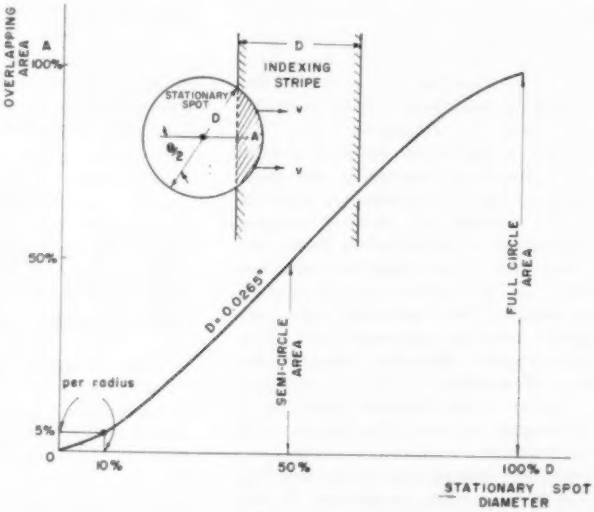


Fig. 3. Signal immersion differentials of indexing spot vs. indexing stripe as a function of spot geometry and current distribution (qualitative).

an indexing system for starting each line scan in place of the triplet-to-triplet indexing method. Reference to the center color position at the start of each horizontal color stripe set could be made, with the single beam running free along the lines and the deflection plates of the gun, affording a fast and constant up and down sweep controlled only to the extent of the horizontal phosphor triplets. Such a high-frequency spot-wobble would contribute to an appreciable cut of the horizontal spot diameter, comparable to non-feedback tubes. However, a stripe array, perfectly matched with the beam paths, would be required. The dynamic spot size would be subject to a twofold cut (x and y), the most favorable condition of the dynamic size-reducing methods. Only one beam would be required, eliminating the need for an indexing raster covering the screen.

Using vertical indexing stripes, a horizontal gain in resolution will occur regardless of storing or not storing indexing materials or methods. This gain is based on the fact that any signal detecting and processing circuit requires a minimum input (response level). The spot will enter the indexing region with a progressively overlapping area, generating a gradual increase of signal energy, depending on the geometry of its leading edge. The shape of the rear edge will, accordingly, control the gradual decrease of the signal intensity, as the spot leaves the indexing stripe.

When the stationary beam spot diameter D (Fig. 3) is comparable to the stripe width, the entrance and exit conditions are more pronounced. Based on Fig. 4 and according to the calculated, progressively overlapping areas A of spot and stripe for D equals 0.0265 in. ($A = [D^2/4] \cdot [\Theta - \sin \Theta]$), a 5% radial loss of the circle area — arbitrarily related to an assumed 5% inactive threshold value of the total indexing output — reduces the effective spot diameter, in horizontal direction, to virtually 80% of its stationary value, or reduces the indexing time to 80%. A uniform current distribution in the spot was here assumed. Knowledge of this mechanism will obviate the need for extremely small beam spots. For geometrical reasons, the smaller the starting spot, the greater the relative reduction in dynamic size.

Figure 3 also shows the conditions created by a square-shaped beam spot. Since the mutually overlapping area here is a linear function of the spot advance, the assumed 5% reaction threshold reduces the spot length D in the horizontal direction by approximately 10%. With a bell-shaped current distribution in the square spot, the horizontal dimension is further reduced by about 15%, while the same bell-shaped current distribution in the circular beam might cause a size reduction of 30%. This may be explained by the fact that proportionality between the immersed spot area and released indexing energy has ceased to exist.

A remarkable advantage stems from the possibility of varying the degree of horizontal resolution by an arbitrary setting of the reaction threshold in the external circuit. In other words, the previously mentioned value of 5% can easily be pre-set either at a lower or at a higher level, arbitrarily increasing or reducing the effective horizontal diameter. By matching the vertical size reduction, an almost circle-shaped dynamic configuration can be artificially produced, as indicated in Fig. 5, which clearly shows the possibility of reducing the stationary spot diameter by 2/3 in both directions. Figure 5 at the right shows how a dynamic brightness spot is formed on a black-and-white screen[1]; similarly, how the vertical spot component is formed is shown at the left in Fig. 5. In the writing beam, the horizontal spot extension can be dynamically reduced during scan only by applying the high-frequency spot oscillation technique, normal to the sweep direction shown for non-feedback tubes.

Conclusions

The foregoing investigations imply that the final dynamic spot size, which is responsible for the ultimate writing resolution of a color tube, can be made smaller than the resting spot in the "x" or "y" direction or both, depending upon the chosen direction of spot motion. By influencing the current distribution in the beam, the severe requirements placed on the electron gun and its cathode can be significantly relieved; that is, larger primary beam spots can be tolerated for optimum color and picture resolution. The possibility of increasing the scanning velocity in combination with a nonlinear phosphor response might also — although not presently realized — become a decisive factor, as the original Lawrence tube with its high-speed oscillatory spot deflection indicates. Since the essential spot size reduction should always result normal to the color stripe array to ascertain color purity (no overlap), the simplest method would be to place the color stripes parallel to the horizontal line scan.

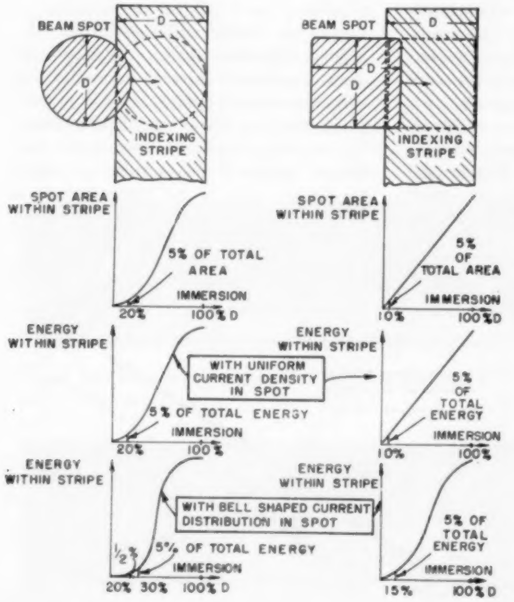


Fig. 4. Calculated interaction area of round indexing spot and indexing stripe if both are of equal width D.

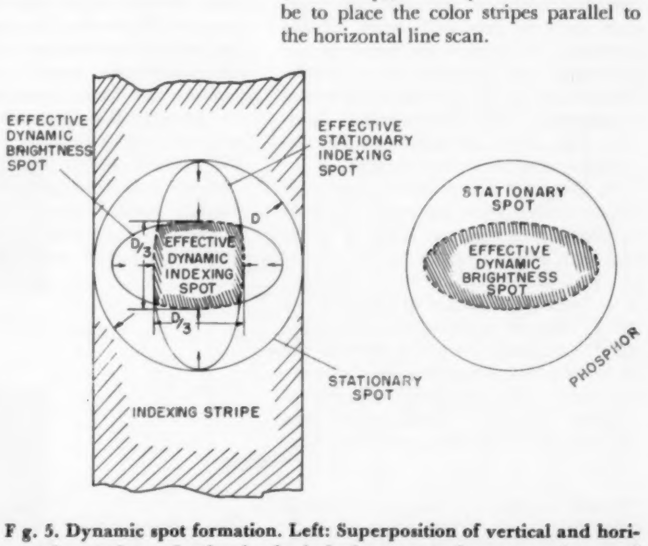


Fig. 5. Dynamic spot formation. Left: Superposition of vertical and horizontal spot size reduction in the indexing spot to form a nearly round small effective spot. Right: Formation of the elliptic dynamic spot or line width when scanning over an extended monochrome screen.

In feedback color systems, reduction of the indexing beam size, as well as of the writing spot by secondary (dynamic) methods, becomes essential, as no feasible electron-optical means is available to afford a substantial cut on the primary spot size. Vertical spot size reduction with horizontal scan is possible only in the presence of energy-storing, indexing or indicator, materials and methods. While a horizontal reduction of the writing spot can be achieved only by vertical high-frequency spot oscillation, the indexing spot exhibits a natural tendency to virtual horizontal size reduction, as the indexing spot enters and leaves the vertically oriented indexing stripe. This is due to the gradual increase and decrease of overlapping areas for signal generation, in conjunction with the reaction threshold of the signal-processing circuits. By arbitrary setting of this external threshold, any desired degree of cutting of the horizontal indexing spot size and of the indexing time can be obtained. If vertical and horizontal spot size reduction are properly matched, a sharply reduced and almost circle-shaped indexing spot can be realized.

Spot size reductions to one-third or less of the original stationary beam size can be achieved with ease by relatively simple secondary means, reducing those difficulties encountered when attempting to achieve fine-focus directly over the gun optics.

References

1. Aurelius Sandor, "Effective spot size in beam scanning tubes," *Jour. SMPTE*, **69**: 735–738, Oct. 1960.
2. Aurelius Sandor, "Grid-controlled fine-focus guns for long beam throw," to be published.
3. Aurelius Sandor, "Emission decay below narrow grid apertures," *Le Vide* (France), 89.

A High-Speed Black-and-White Negative Film

By F. W. SPANGLER
and H. R. BEILFUSS

The new camera film, Eastman Double-X Panchromatic Negative Film, Types 5222 (35mm) and 7222 (16mm), has been designed to give more than twice the speed of Eastman Plus-X Panchromatic Negative Film (Type B), Types 4231 (35mm) and 7231 (16mm), without a significant increase in graininess of prints made therefrom. This permits exposures under adverse lighting conditions, or with increased depth of field without an increase in illumination, or with greater economy in set lighting. The new film will find wide application for general motion-picture work and television use. Processing and printing procedures are compatible with those used for Types 4231 and 7231. The characteristics of the film which affect picture quality are discussed.

THE ART of manufacturing negative photographic emulsions has undergone a tremendous change since the introduction of panchromatic motion-picture negative film in 1913. Very little panchromatic negative film was used, however, until the year 1928, when notable technical advances were made in the motion-picture industry as a whole. These included the introduction of sound photography and Mazda studio lighting. The latter provided an inducement for using panchromatic film.

In the years that followed, numerous improvements were made in emulsions to give the cameraman a much better tool with which to enhance the quality of his photographic work. Among these improvements are found increased speed, reduced graininess, higher acutance[1] (a factor which expresses the ability of a film to produce sharp images), improved color sensitivity, changes in contrast, modified development rates and improved emulsion stability. Negative films were designed for general use as well as for special purposes. In the latter category we find emulsions of extremely fine grain for projection background work and extremely fast emulsions for use under poor lighting conditions. Whenever new products were introduced, substantial improvements in photographic quality were realized.

Since the most important product in photography is undoubtedly the original camera negative film on which the various scenes are photographed, research and development work is continually carried out to improve such materials. The present paper is concerned primarily with the characteristics of the new high-speed black-and-white camera negative film recently made available by the Eastman Kodak Co., and how it compares with Eastman Plus-X Panchromatic Negative Film (Type B)[2] and Eastman Tri-X Panchromatic Negative Film.[3] At the time of this writing, both the Plus-X and the Tri-X are in general use in the motion-picture and television fields.

The Need for a New Film

The desire for higher emulsion speed and lower granularity has always been a driving force behind the notable advances in photographic emulsion technology. Manufacturers of photographic films are keenly aware, however, that simultaneous improvements in both these properties do not come about easily. In order to acquire a substantial gain in one property, it is often necessary to accept little or no improvement in the other. For a number of years now, Eastman Plus-X has represented an excellent balance between the maximum desirable speed for most purposes and the lowest granularity possible at that speed.

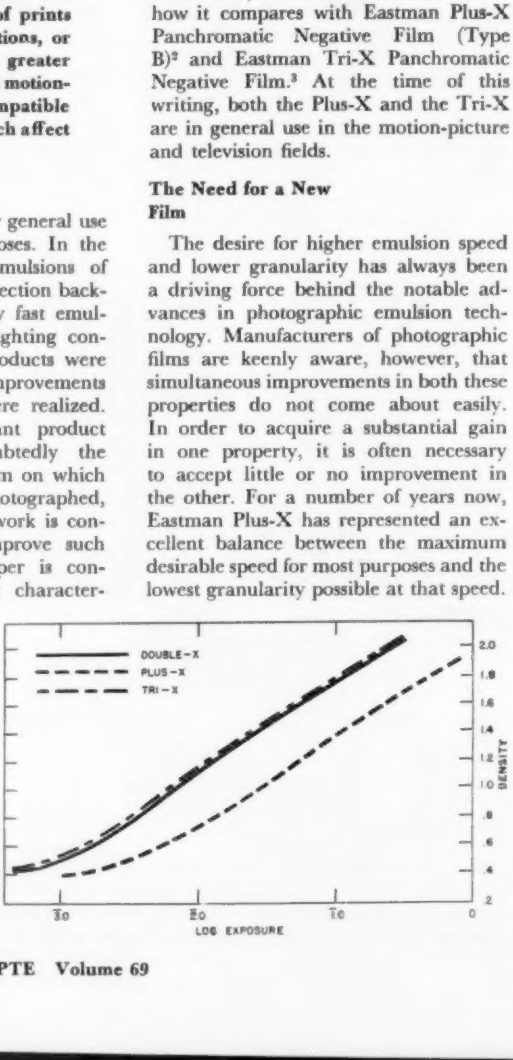


Fig. 1. Density-log exposure curves for Eastman Plus-X, Double-X and Tri-X Panchromatic Negative Films.

Presented on May 4, 1960, at the Society's Convention in Los Angeles, Calif., by F. W. Spangler who read the paper, and H. R. Beilfuss, Film Emulsion Div., Kodak Park Works, Eastman Kodak Co., Rochester 4, N. Y.
(This paper was received on August 3, 1960.)

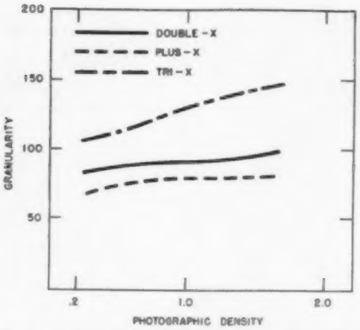
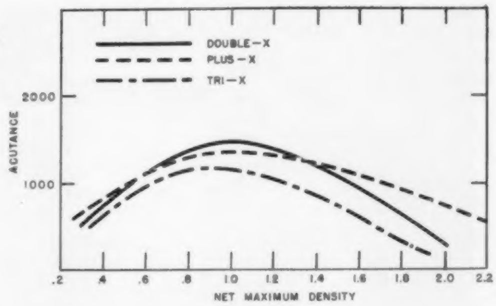


Fig. 2. Granularity-density curves for Eastman Plus-X, Double-X and Tri-X Panchromatic Negative Films.

Fig. 3. Acutance-density curves for Eastman Plus-X, Double-X and Tri-X Panchromatic Negative Films.



To complement this, Eastman Tri-X has been available for those instances where pictures must be made under extremely poor lighting conditions, such as might be encountered in newsreel photography. Here the higher speed is more important than the graininess shown in prints.

This situation has gradually changed, however, with the increasing importance of available light photography, of the use of larger sets for wide-screen pictures, and of demands for greater economy in set lighting in productions for television use. It became evident that a negative film of about the speed of Tri-X but with lower granularity would be increasingly important. Since a new film of such characteristics would be more useful to the industry than one having still more speed, experimental efforts were directed toward this end. The new high-speed black-and-white negative film described in this paper is the result of that work.

Photographic Properties

The new product is designated Eastman Double-X Panchromatic Negative Film, Types 5222 (35mm) and 7222 (16mm). The emulsion is coated on the same gray triacetate safety support that is used for other Eastman negative motion-picture films. Based on recent advances in emulsion manufacturing techniques, the new material has two to three times the speed of Plux-X with only a slight increase in granularity. This is true under either daylight or tungsten illumination conditions. Figure 1 shows the speed of Double-X relative to the speeds of Plus-X and Tri-X when the three films are processed to equal gammas. This improvement in the "speed : graininess" ratio is particularly evident at higher densities. While other negative films show considerable increases in granularity with overexposure, the Double-X exhibits only a slight change. Granularity measurements[4] at a contrast of 0.70 indicate that the new film has a granularity rating somewhat less than midway between those of Plus-X and Tri-X, as seen in Fig. 2.

In addition, the acutance measurements[1] in Fig. 3 show that the Double-X has the same ability as the Plus-X to produce sharp images. Combining the fine grain and high acutance with a speed only 0.10 log E less than that of the Tri-X, we have a high-speed negative film of excellent quality. Such a material is well suited to general interior and exterior photography under both average and adverse lighting conditions. Its speed is particularly valuable in permitting the use of small apertures in order to obtain good depth of field without increasing the illumination.

Samples of the Double-X film have been distributed to the industry for evaluation. A summary of the reports received to date substantiates the claim that the new product is fully two to three times as fast as the Plus-X with only a slight increase in graininess of prints made therefrom. Double-X truly represents a new balance between the maximum desirable speed for most purposes and the lowest granularity available at that speed. The new film should find particular application in the television field where greater flexibility in lighting on the set is an important factor. In addition to the economic benefits that may be derived from reduced lighting requirements, more comfortable working conditions for the actors will be realized with the attendant lower temperatures on the set. The increased speed also permits the photographing of subjects previously considered to be inadequately lighted. Although the Double-X film may become widely used as a general-purpose film for both motion-picture and television use, in those instances where extremely high speed is not required the Plus-X will still remain as the highest quality film available.

Exposure

The exposure indexes recommended for Eastman Double-X when developed to a gamma of 0.70 are Daylight-250 and Tungsten-200. Illumination (in-

Fig. 4. Spectrogram to sunlight for Eastman Double-X Panchromatic Negative Film.

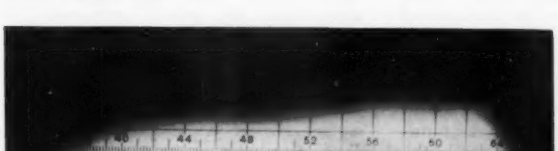


Fig. 5. Spectrogram to tungsten light for Eastman Double-X Panchromatic Negative Film.

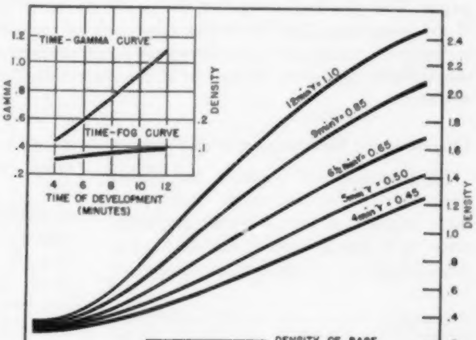


Fig. 6. Density-log exposure curves for Eastman Double-X Panchromatic Negative Film.

Table I. Illumination (Incident Light) for Tungsten Light. (Shutter speed, approx. 1/50 sec; 24 frames/sec; 170° shutter opening.)

Lens apertures	Foot-candles required
f/1.4	13
f/2.0	25
f/2.8	50
f/4.0	100
f/5.6	200
f/8.0	400

cident light) values for tungsten light are found in Table I.

Although the color sensitivity of the new film is very similar to that of the Plus-X and the Tri-X, slight differences are seen in the filter factors listed in Table II.

Spectrograms to sunlight and to tungsten light are shown in Figs. 4 and 5, respectively.

Processing

An important feature of Eastman Double-X is its complete compatibility with the existing processing conditions used for Plus-X and Tri-X. Like other Eastman negative films, it is intended for processing by the customer in a normal motion-picture negative developer such as Kodak D-76. Some modification of the latter is usually required for each type of processing installation and mode of operation. Because of this variety of processing in the industry, it is not practical to give specific development recommendations.

Figure 6, however, shows a family of characteristic curves for a range of development times in such a negative type developer at 68 F, as well as the corresponding time-gamma and time-fog curves. The development time for the Double-X to reach a gamma of 0.70 is about halfway between the times required for the Plus-X and the Tri-X to reach the same gamma. Fixing, washing and drying operations are similar to those used for other negative films. The new film is not intended for processing at elevated temperatures. In the handling and storage of raw stock or processed film, the same precautions recommended for other black-and-white negative films should be observed.

Summary

A new high-speed black-and-white camera film, Eastman Double-X Panchromatic Negative Film, Types 5222 (35mm) and 7222 (16mm), has been described. The new product, with its low granularity and high acutance, should find wide application in the motion-picture and television fields. Processing and printing procedures are compatible with those of films currently used.

Table II. Filter Factors for Sunlight

Kodak Wratten Filter No.	Filter Factor Double-X	Plus-X	Tri-X
3 (Aero 1)	1.5	1.5	1.5
8 (K2)	2.0	2.0	2.0
Minus Blue 12	2.0	2.0	2.5
15 (G)	3	2.5	3
21	3	3	3.5
23A	5	5	5
8N5	5	5	5
25	8	8	8
29	20	16	25
ND-3	8	8	8

Note: At the conclusion of the paper, a demonstration film was projected showing Eastman Fine Grain Release Positive Film prints made from Plus-X, Double-X and Tri-X negatives.

References

1. T. H. James and G. C. Higgins, *Fundamentals of Photographic Theory*, 2nd Ed., pp. 287–288, Morgan & Morgan, New York, 1960.
2. E. Huse, "Eastman Plus-X Panchromatic Negative Film (Type B)," *Am. Cinemat.*, 37: 542, 562, Sept. 1956.
3. E. Huse, "Tri-X—New Eastman High-Speed Negative Motion Picture Film," *Am. Cinemat.*, 35: 335, 364, July 1954.
4. T. H. James and G. C. Higgins, *Fundamentals of Photographic Theory*, 2nd Ed., pp. 268–280, Morgan & Morgan, New York, 1960.

An Electrostatic Color Map Printer

By DONALD J. PARKER and F. C. MYERS

A feasibility model of an electrostatic color map printer using Electrofax paper has been constructed and demonstrated under a contract with the U.S. Army Engineering Research and Development Laboratories, Fort Belvoir, Va. This machine is designed to print five-color, 22½ by 29-in. maps by optical exposure from 70mm cartographic separations. The feasibility equipment uses liquid color Electrofax development with electronic flash exposure triggered photoelectrically from the paper. The machine is web fed, the paper transport being accomplished by means of air bearings. The Electrofax approach to tactical map reproduction greatly reduces the requirement for storage of large quantities of printed maps. It reduces the logistics problems to supply of raw material. The make-ready time is a few minutes.

The Need for Electrostatic Map Printing

Modern warfare requires the abundant use of tactical maps. Supplying these maps is a very difficult problem, since it is not known at the start of a field engagement exactly what maps are going to be required, and even worse, what quantities of the particular maps will be needed. Hence, to ensure the availability of up-to-date maps, large quantities of maps must be transported into the field. A major percentage of these maps are never used or become obsolete. Another less obvious problem is that these large map stores are difficult to destroy under circumstances of impending capture and are a security risk.

It would be most advantageous to be able to reproduce maps in the field from a low-volume store such as miniature film slides of the cartographic separations. This would allow the supply of maps in exactly the needed quantities; and the film slides could readily be transported or destroyed in dangerous situations. Most importantly, the logistics problem would then become one of the supply of raw materials; the information for the map is on the miniature film slide, and to supply new or updated maps, only film slides need to be transported to the field, instead of tons of finished maps.

The ideal process for map reproduction in the field would provide finished maps directly from the miniature film separations by optical exposure. It should not require sensitized materials, however, because they may be vulnerable to spoilage by spurious exposure to light or radiation. The processing system should be simple, so that the map reproduction equipment can be small and lightweight, although still sufficiently rugged for field transportation.

Presented on May 2, 1960, at the Society's Convention in Los Angeles by L. J. Krolak for the Authors, Donald J. Parker, Radio Corp. of America, Applied Research, Defense Electronic Products, Camden 2, N. J., and F. C. Myers, U.S. Army Engineering Research and Development Laboratories, Fort Belvoir, Va.
(This paper was received on June 22, 1960.)

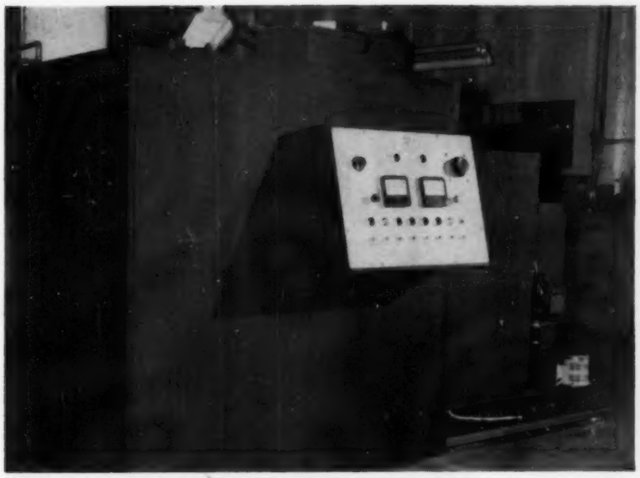


Fig. 1. Electrostatic Color Map Printer.

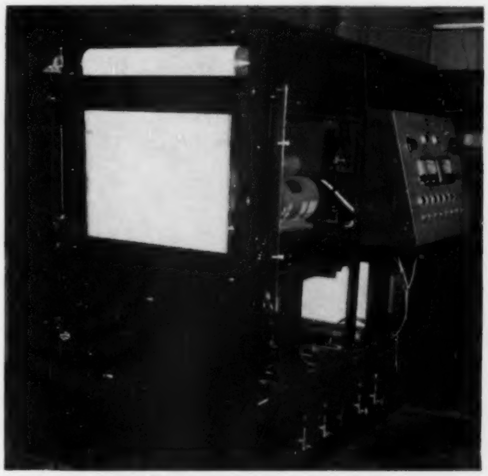


Fig. 2. Printer with several doors removed.

An electrostatic printing machine utilizing RCA Electrofax paper offers exactly these characteristics. This system for electrostatic printing sensitizes the printing paper just prior to exposure. Also, a new liquid development process allows development in a number of colors with very simple and noncomplex equipment, and at a rate suitable for map reproduction in the field.

In order to examine thoroughly the usefulness of electrostatic printing for map reproduction, a feasibility model of an Electrostatic Color Map Printer was developed by the Radio Corp. of America for the U.S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va., under a Department of the Army contract. This machine produces maps from 70mm cartographic separations, developing the optically exposed map in any one of five colors at the rate of 16 in./sec. This experimental equipment has established the feasibility of multicolor map reproduction by electrostatic techniques. The resolution, dimensional stability and general map quality realized on this first machine gives great promise for a revolutionary field map-reproduction system.

The Electrostatic Color Map Printer

The feasibility model utilizes both RCA Electrofax paper (zinc oxide coated paper) and RCA Liquid Development. During the operation of the printer the surface of the Electrofax paper is given a blanket static charge. Charged Electrofax paper discharges when it is exposed to light; consequently, if a transparency is placed between the charged Electrofax paper and the light source, only the portion of the paper which has "seen light" will discharge; the other portion (unexposed) will retain its static charge. When the surface of the paper is contacted with a suspension of charged particles in a nonpolar liquid, the electrostatic image becomes neutralized by the adhesion of particles to these areas. The adhesion of these particles (pigments) to the paper is the developing process. For multicolor printing the above processes are repeated, a different developer solution being used for each color.

The Electrostatic Color Map Printer thus consists of four major processes: paper transport, charging, exposure and development. All these components are integrated within a sheet-metal, light-tight shell. Figures 1 and 2 show the printer and the printer with several sheet-metal doors removed.

RCA Electrofax paper is fed from a paper feed roll through a charger, (Fig. 3). The charger is a device which imparts a blanket static charge to the surface of the paper. An exposure station immediately follows the charger. At the exposure station a photocell detects a slot in the web and triggers a flashlamp. The flashlamp projects an image of a cartographic separation on the moving charged web, thereby discharging the portion of the web which has been exposed.

After passing through the exposure station, the web travels through the developing area. At this station a partially submerged, motor-driven roller picks up a film of the developing fluid from a tray and transfers some of the film from the surface of the roller to the surface of the moving paper. The charged particles (pigment) of the developing fluid adhere to those portions of the web which have an electrostatic charge on it. The adhesion of the pigment to the paper neutralizes the remaining charges on the paper surface. The developed paper is rolled up by a motor-driven paper take-up roll.

When the desired quantity of maps have been made, the paper is rewound onto the feed roll. The above process is repeated for each color of the map.

Paper Transport

The paper transport consists of a system whereby the paper is fed from a

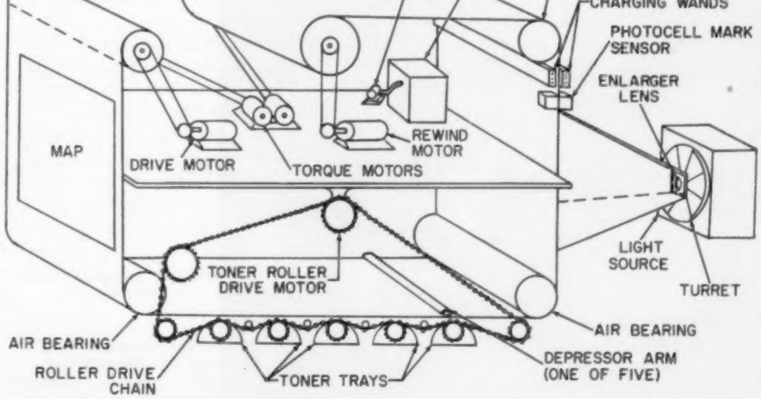


Fig. 3. Printer interior.

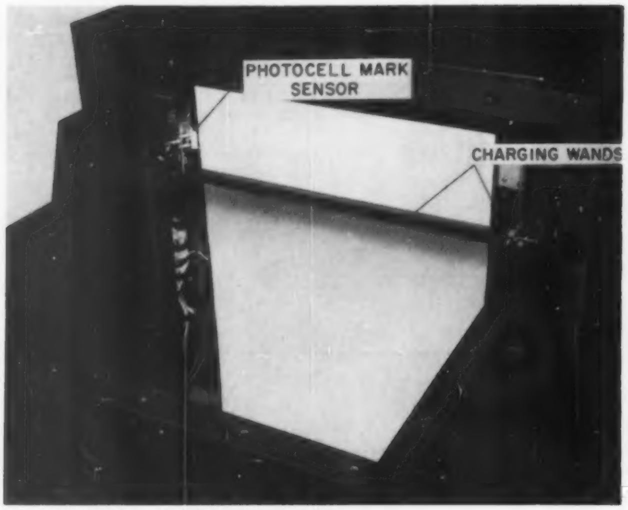


Fig. 4. Charging and Exposure Station.

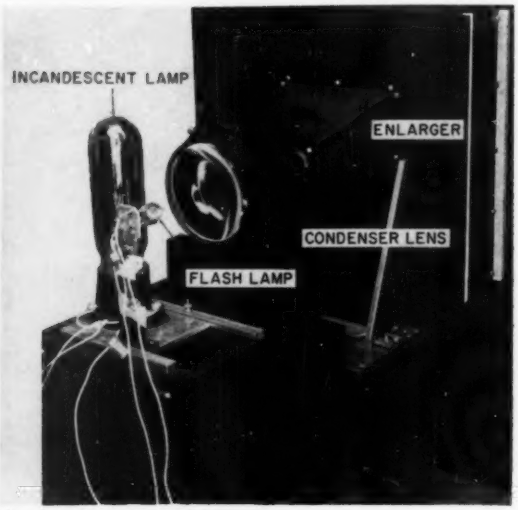


Fig. 5. Printer Optical System.

supply roll, passed through the process stations, and is wound on a take-up roll.

The paper web is supported, and given directional change, by three air-lubricated bearings (Fig. 3). Flow of air through a porous bearing material results in an air pad which supports the paper web at a positive displacement from the bearing. By means of this support medium, it is possible to transport the paper web without paper-to-metal contact at the bearings. Air bearings are used for this particular application because of the following four advantages. First, this type of bearing is less expensive to fabricate than conventional bearings. Second, minimum friction resistance is introduced into the system by using air bearings. The third advantage is the elimination of random charge generation on the paper, resulting from paper-to-metal contact; this random charge is a possible source of degradation in electrostatic printing. The fourth reason for using air bearings is that by supporting the paper web on an air pad, it is possible that edge guiding equipment can be used; this allows for the investigation of inexpensive lateral registration.

Charging

A blanket static charge is introduced on the zinc oxide coated surface of the paper by two charging units. Each unit consists of a bank of three molybdenum wires, each $2\frac{1}{2}$ mil in diameter. These banks of wires are located approximately $\frac{1}{4}$ in. from the web surfaces. Two high-voltage d-c power supplies are wired to the charging units. The charging unit for the front surface of the paper is set at a negative potential; the unit for the back surface has a positive potential to simulate ground conditions. These units generate a corona discharge which provides a blanket static charge on the paper. Figure 4 shows the web passing through the charging units. The equipment at the upper left of the photograph is the transistor photocell used to detect registration marks.

Exposure

A General Electric flashlamp serves as the light source for the exposure station. The lamp has an output energy level of approximately 125 wsec and a flash duration of 55–80 μsec. The light which comes from this lamp passes through a condenser lens, a film separation and an enlarger lens. The image of the separation is projected upon the paper. Figure 5 shows the optical system. The film separations are held in a circular turret. Figure 6

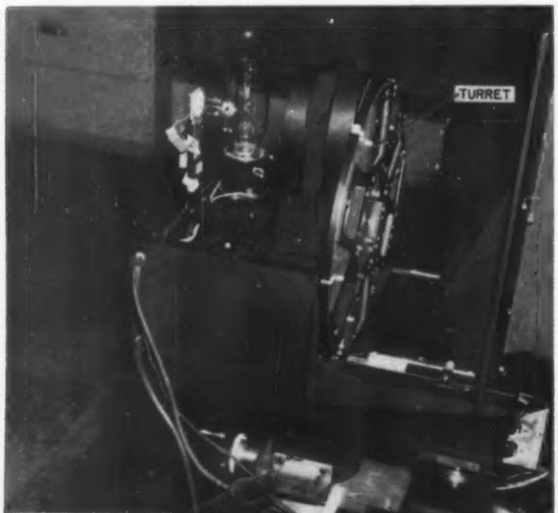


Fig. 6. Projector Assembly.

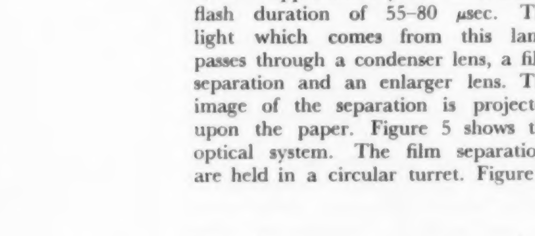


Fig. 7. Schematic of developing solution application.

is a photograph of the optical system and turret.

Because of the relatively slow paper speed, 0–16 in./sec as compared to the flash duration of 55–80 μsec, the paper web can continue at a constant velocity while being exposed without significant line blur.

The incandescent lamp shown in Fig. 5 is used to project the image onto the paper during the focus and registration adjustments. This lamp may be moved out of the optical path when adjustments have been completed.

Developing

Development of the exposed web is accomplished by bringing the paper into contact with a film of developer. Developer fluids containing different pigments are held in a series of five toner trays located along the lower level of the map printer.

A bearing-supported depressor arm is located above each tray. The paper web is threaded between the depressor arm and a smooth roller (which is partially submerged in the tray). The depressor arms are air lubricated to prevent paper-to-metal contact. Each tray is equipped with a metal roller. The rollers rotate in a direction opposite to that of the print travel and carry a film of developer solution on their surface. Owing to the proximity of web and roller, some of the film is transferred from the roller to the paper as illustrated in Fig. 7. It is this film which develops the image.

Figure 8 shows the last three developing stations and the final air guide for the paper web. The unprinted, exposed web is positioned by the depressor arm so that it is approximately 0.003 in. above the surface of the active toner roller.

Controls and General Information

The flashlamp may be triggered in two ways. A manual trigger switch is located on the control panel. This switch allows the operator to expose the charged paper at will. The other method is an automatic trigger system. This system consists of a transistor photocell, a light source and associated circuitry. The light source and photocell are located on opposite sides of the paper web immediately above the charging units. The photocell detects slots in the paper web and triggers the flashlamp automatically. This provides registration in the running direction of the paper web, since each separation for a particular map will be triggered from the same slot.

A control panel is provided which permits the operator to control the printing process from one position, with two exceptions. It is necessary for the operator to select manually the proper toner tray, and it is necessary for the operator to change manually the position of the film separation turret. All motor controls are located on the control panel. Control potentiometers and voltmeters for the charging units, a variable paper speed control and a variable tension control are also provided at the control panel. The operator may also select either manual exposure or automatic exposure from this position.

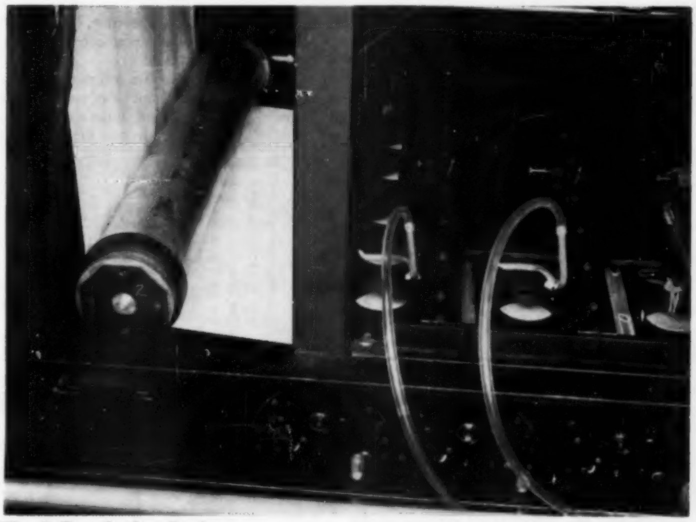


Fig. 8. Developing Station.

Evaluation

The large amount of experience obtained with the Electrostatic Color Map Printer may be summarized by the following conclusions:

(1) Frame exposure from 70mm cartographic separations may be accomplished with sufficient resolution and uniformity.

(2) The liquid Electrofax development process gives excellent results and is easy to mechanize. The development may be accomplished without causing dimensional changes in the paper, and at relatively high speeds.

(3) Color overprinting may be accomplished with liquid Electrofax development without using an intermediate fix.

(4) Electronic flash exposure of the paper may be accomplished while the paper is moving without deteriorating the quality of the image. Automatic triggering of the flash may be accomplished with sufficient accuracy to meet lateral registration requirements.

(5) Background density in multicolor maps is much lower than it has been possible to achieve with other electrostatic printing processes.

Discussion

Anon: Could you first give us a figure as to the resolution capabilities of this particular material; secondly, in your re-registration, what is the exactness of re-registration, of continuous—I mean for reproducible printing; and thirdly, what is the time required for drying, prior to being able to handle this material?

L. J. Krolak (who read the paper): As to resolution—depending again on what kind of operation you're working with and what kind of mechanization you have—an average figure would be between 1000 and 600 TV lines per inch. This covers hand operation and mechanized operation, respectively.

Your second question about re-registration: I believe that the longitudinal re-registration was within two or three thousandths of an inch.

As for the handling time—we have done a lot of work with this. We have worked with self-fixing developers which we have put into the developing tanks, i.e. isobutyl methacrylate and this can be handled after 15 to 20 seconds. We have tried out many types of solutions. The most successful seems to be a 50–50 solution of Freon and silicone. Using Freon alone, which has a very high evaporation rate, you can handle these maps perhaps after only 5 or 6 seconds. The Freon does have problems in that it evaporates so fast that you lose the liquid in the developing tanks very rapidly. One way of getting around this is to cool the tanks and we have done this also. But the most successful combination so far seems to be a 50–50 solution of Freon and silicone and these maps can also be handled after 10–15 seconds.

Anon: Do you perchance use a post-treatment in any manner to stabilze or preserve the image?

Mr. Krolak: No, we have applied the isobutyl methacrylate both during developing and after development. If we don't put it on in the development stage, it can be applied after development by spray technique or simply by putting the finished map into a solution of isobutyl methacrylate.

Anon: Would you comment on the durability of the maps in the field, particularly as to folding and resistance to moisture?

Mr. Krolak: Well, with the isobutyl methacrylate coating the maps are very rugged. If you fold them they do not crack. As for figures about how they would last, there is no reason why they shouldn't last several years. As far as folding and rolling, we have had these maps around the labs for a year or more now, and they are still folded and rolled and you can take them out and they still look very good and none the worse for use.

Karl-Heinz Lohse (Aeronutronic, a Division of Ford Motor Co.): Again, regarding registration: you did not mention what film you used for separation. Is your 70mm film an acetate base film?

Mr. Krolak: I really don't know; it may have been acetate or it may have been Mylar.

Mr. Lohse: How would you handle your black printer if you carried the black printer information in the three separation colors, how close is your overprint—in registration terms again? In your separation films, you will have more map colors, of course, than you have tones available, so would you overprint two colors to produce a third one?

Mr. Krolak: No, we did not use additive color mixture. When I speak of overprinting, I refer to electrostatic printing on a surface on which a developed image already exists. The printer of which I speak contained a separate color toner for each color to be printed.

Mr. Lohse: Then you are not using standard Army maps?

Mr. Krolak: We are printing from reduced cartographic separations of standard Army maps.

standards and recommended practices

Revision of American Standards

On August 29, 1960, the American Standards Association, Incorporated approved the following American Standards:

PH22.27–1960, Method of Determining Transmission Density of Motion-Picture Films (revision of PH22.27–1947)

PH22.50–1960, Reel Spindles for 16mm Motion-Picture Projectors (revision of PH22.50–1946)

PH22.62–1960, 9 kc Sound Focusing Test Film for 35mm Motion-Picture Sound Reproducers (revision of PH22.62–1948)

PH22.67–1960, 1000-Cycle Balancing Test Film for 35mm Motion-Picture Sound Reproducers (revision of PH22.67–1948)

The standards were approved by the Society's Engineering and Standards Committees and ASA Sectional Committee PH22. Since they reflect no technical change from the versions published previously, the standards are not being published here. The editorial changes incorporated in the new revisions consist of the following:

PH22.27: American Standard for Diffuse Transmission Density, Z38.2.5–1946, which is the basis for PH22.27, was revised. Therefore, the reference to this standard has been changed to PH2.19–1959.

PH22.50 now contains a scope which reflects the purpose of the standard.

PH22.62 and .67: The reference to applicable standards has been brought up to date, the word "record" has been substituted for "track" in section 2.2 and the note relating to the availability of test films made in accordance with the standards has been corrected to indicate the current source of supply which is the SMPTE. PH22.67 has also been given a more descriptive title.

The standards may be obtained from the American Standards Association, Incorporated, 10 East 40 Street, New York 16, N.Y., at a nominal cost.—*J. Howard Schumacher, Staff Engineer.*

Proposed American Standard

A Proposed American Standard, 16mm Television Intermittent Projector for Vidicon Camera Operation, PH22.125, is published here for a three-month period of trial and comment.

The need for a standard relating to a 16mm television intermittent projector for vidicon camera operation was recognized by the SMPTE Television Committee during its October 1955 meeting. A subcommittee under the chairmanship of Dr. H. N. Kozanowski was constituted to formulate a draft proposal. The first draft was based on American Standard, 16mm Motion Picture Projector for Use With Monochrome Television Film Chains Operating on Full-Storage Basis, PH22.91–1955. Subsequent to its circulation in 1956, three additional drafts were submitted to the Television Committee before agreement was reached on this proposal.

The members may be interested in the fact that the Television Committee at its May 4, 1960, meeting voted unanimously to recommend the withdrawal of PH22.91–1955 subsequent to ASA approval of PH22.125.

This published version has been approved by the Standards Committee and if no adverse comments are received prior to January 15, 1961, it will be submitted to ASA Sectional Committee PH22 for further processing as an American Standard. All comments should be addressed to Society Headquarters, attention of J. Howard Schumacher, Staff Engineer.—*J.H.S.*

—Proposed American Standard—

16mm Television Intermittent Projector for Vidicon Camera Operation

PH22.125

1. Scope

1.1 This standard applies only to 16mm motion picture projectors in which the film is advanced intermittently.

1.2 This standard describes two types of projectors in combinations with vidicon TV camera chains. The first operates on a full-storage basis, and the second on a partial-storage basis. The standard applies to both types unless otherwise specified.

1.2.1 In synchronous operation the projector motor and the television system vertical period generator are locked to the same frequency, generally the alternating-current power supply.

1.2.2 In nonsynchronous operation the projector motor and the television synchronizing generator are not locked to each other and their frequencies may differ by a maximum of 0.5 cycles per second.

1.2.3 In full-storage operation illumination from the projector is restricted to the vertical retrace period of the television scan.

1.2.4 In partial-storage operation the illumination will not be restricted to the vertical retrace period but may occupy a portion of the vertical scanning time.

1.3 The characteristics of the projector are standardized in terms of the one-inch vidicon which has now displaced the iconoscope used as the basis of American Standard 16mm Motion Picture Projector for Use with Monochrome Television Film Chains Operating on Full-Storage Basis, PH22.91-1955.

2. Image Dimensions

2.1 The image on the face of the vidicon shall be $\frac{3}{8}$-inch (height) × $\frac{1}{2}$-inch (width), a $\frac{5}{8}$-inch diagonal.

2.2 In a relay type optical system, the image projected on the field lens shall be $3\frac{3}{8}$-inches (height) × $4\frac{1}{2}$-inches (width), a $5\frac{5}{8}$-inch diagonal.

2.3 The projector shall contain adequate provisions for meeting all specifications of 2.1 (direct-in projection) and 2.2 (relay projection).

3. Projection Lens Resolution

3.1 Resolution shall be defined and measured in accordance with American Standard Method of Determining Resolving Power of 16mm Motion-Picture Projector Lenses, PH-22.53-1953 (see Section 19), except that measurement shall be made with the standard picture widths. (See 2.1 and 2.2.)

3.2 The resolution shall be at least 80 lines per millimeter for the patterns identified as E and D and at least 90 lines per millimeter for all others.

4. Optical Axis Adjustment

4.1 The projector shall include, or have available as an accessory, a sturdy pedestal. Means shall be provided to place the optical axis (when level) at any height from 47 to 49 inches from the floor.

4.2 A tilting mechanism shall be included although this need not permit either quick change or change during operation. The minimum range of tilt shall be ± 2 degrees.

4.3 A leveling mechanism capable of rotating the projector about an axis parallel to the optical axis shall be included.

4.4 The vidicon camera may be affixed to the projector as an integral part with appropriate optics. In this case the camera mount shall be provided with appropriate means of horizontal, vertical, and axial adjustments.

NOT APPROVED

5. Film Gate Dimensions

The dimensions of the picture aperture and its location relative to the film shall be in accord with American Standard Projected Image Area of 16mm Motion-Picture Film, PH22.8-1957. (See Section 19.)

6. Framing Device

6.1 The projector shall have a readily accessible means for positive framing of the picture when the projector is in operation. The range of the framing mechanism shall extend 0.025 inch above and below the standard position measured at the film. The framing device shall be free from creep during operation.

6.2 The method employed for framing shall not change the horizontal position of the projected image of the picture aperture by more than 1.0 percent of the picture width over the full framing range.

7. Picture Stability

7.1 *Definition.* The stability of the image depends upon the ability of the projector to locate succeeding frames of film in exactly the same position relative to the picture aperture. Failure to perform this function perfectly results in either jump (vertical instability) or weave (horizontal instability) or both.

7.1.1 Jump and weave shall be measured in terms of the peak-to-peak excursions observed. In each case the result shall be stated as a percentage of picture width.

7.2 Standard

7.2.1 Jump shall not exceed 0.2 percent of picture width.

7.2.2 Weave shall not exceed 0.15 percent of picture width.

8. Image Illumination

8.1 *Methods of Light Application.* Illumination can be applied from the projector to the vidicon either as a single light pulse per television field or as a plurality of pulses per television field. It is important that successive television fields receive substantially the same exposure both in timing and intensity to eliminate flicker disturbances.

8.2 Means shall be provided either internal or external to the projector to control the light intensity reaching the face of the vidicon over a range of 100 to 1 without introducing changes in color temperature.

8.3 *Intensity of Illumination.* The intensity of illumination shall be measured along the 0.625-inch diagonal of the image in the plane of the photo-surface of the vidicon. The objective for the time-averaged illumination as measured in a highlight area is a minimum of 100 foot-candles, under the most adverse conditions of motion picture film transmission density.

8.3.1 *Measurement of Intensity.* The intensity of illumination shall be measured as follows:

(1) With projector running and no film in the gate

(2) Light intensity control at maximum intensity position

(3) Image size: (a) $\frac{3}{8}$-inch × $\frac{1}{2}$-inch for direct-in use; (b) $3\frac{3}{8}$-inches × $4\frac{1}{2}$ inches, for field lens use

The intensity of illumination shall be at least 40,000 foot-candles, for direct-in use, or 500 foot-candles, for field lens use.*

8.3.2 Uniformity

(1) With no film in the gate, intensity of illumination at any point in the area of the standard image shall be not less than 80 percent of the maximum intensity of illumination.

(2) Upon replacement of an incandescent projection lamp, if such is used, no re-adjustment shall be required to achieve this distribution.

(3) The receptive area of the light sensitive element used for these readings shall have a diameter not greater than 5 percent of the picture width. No reading shall be taken with the center of the receptive ele-

* This is the product of Recommended Vidicon Illumination (100 foot-candles) × Color System Attenuation Factor (20) × Reserve for Dense Film (20).

NOT APPROVED

ment closer to the edge of the image area than 5 percent of the picture width.

(4) For direct-in projection systems, uniformity measurements can be made using the vidicon camera and an oscilloscope equipped with a line selector.

8.4 *Color Temperature.* The projector shall be capable of providing illumination of color temperature 2870 K (illuminant "A"). This standard is required to facilitate multiplex operation in a color television system.

8.5 Illumination Period

8.5.1 *Definition.* The illumination period is the interval of time in which the instantaneous intensity of illumination in any part of the image area exceeds 10 percent of the peak instantaneous intensity.

8.5.1.1 The length of the illumination period shall be stated in terms of a percentage of *V*, where *V* is the time from the start of one television field to the start of the next field.

8.5.2 *Standard.* Illumination period shall not exceed 6.5 percent of *V* for full-storage operation.

8.5.2.1 For partial-storage operation the illumination period shall be as large as possible. It shall be 25 percent, or more, of *V*.

8.5.3 *Method of Measurement.* The illumination period shall be measured by means of a photocell, an amplifier, an oscilloscope and a timing oscillator. The photocell and amplifier must respond without saturation to the peak intensity encountered and the frequency response of the combination shall be down not more than 3 decibels (db) at 50 kilocycles (kc).

9. Pull-down Period

9.1 *Definition.* The pull-down period is the interval of time in which film is moving through the picture aperture.

9.2 *Standard.* The only restriction to be placed on the pull-down period is that it shall never overlap any part of the illumination period.

9.3 *Method of Measurement.* The existence of overlap may be detected by projecting a test subject consisting of sharply defined white objects on a black background, and inspecting the projected picture for evidence of travel ghost.*

10. Phasing of Projector Relative to TV Vertical Scan for Full-Storage Operation.

10.1 For the case of a fixed relation between pull-down and illumination periods:

10.1.1 Means shall be provided for setting the illumination period in any desired phase relative to the 60-cycle frequency which controls the phase of the motor.

10.1.2 Each time the projector is turned on, it shall re-establish this pre-selected phase relation by fully automatic means in less than 3 seconds.

10.1.3 During operation, the preselected phase relation shall be maintained within $\pm\frac{1}{2}$ percent of *V*.

10.2 For the case of the illumination period locked to the vertical synchronizing signal and independent of the pull-down period, means shall be provided for insuring compliance with 9.2 of this standard.

11. Film Capacity and Film Tension

11.1 The projector shall accommodate reels of any capacity from 400 to 3600 feet which comply with the requirements of American Standard for 16-Millimeter Motion-Picture Projection Reels, PH22.11-1953. (See Section 19.)

11.2 For any reel size in this range, the take-up tension shall at no time be less than 3 ounces nor greater than 10 ounces (hub diameters less than 4.5 inches excepted).

11.3 For any reel size in this range, the braking mechanism on the feed reel shall not cause a tension greater than 3 ounces (hub diameters less than 4.5 inches excepted).

12. Film Life

12.1 After 100 passages through the projector mechanism, film shall exhibit no evidence of damage either visible in the projected picture or audible in the reproduced sound signal.

NOTE: In order that a loop of film may be used in this test, renewal of the splice as many times as may be necessary is permitted.

12.2 The film used in this test may and should be carefully selected and lubricated. The projector is not required to pass this test with film which is in inferior condition.

12.3 Passage of a splice in good condition through the mechanism shall not cause serious disturbance, such as loss of loop, nor shall the mechanism cause excessive damage to the splice.

13. Starting Time

13.1 *Definition.* The interval between applications of power and the attainment of: (1) synchronous operation of the motor and (2) a flutter content in the sound output which is less than the maximum specified in 17.2.

13.2 *Standard.* The starting time shall not exceed 5 seconds.

14. Film Speed

The nominal speed of projection shall be 24 frames per second. This shall not be interpreted as excluding the use of a 3-2 mechanism.

15. Stopping Distance

15.1 *Definition.* The length of film that passes through the film gate after removal of power.

15.2 *Standard.* The stopping distance shall not exceed 3 feet.

16. Manual Drive

Some readily accessible means shall be provided for slow-speed manual operation of the mechanism as a check on threading, etc.

17. Sound Scanning System

17.1 *Synchronization.* The film path distance measured in the direction of travel from the center of the picture aperture to the point at which optical sound scanning occurs shall be 26 frames $\pm\frac{1}{2}$ frame. Where magnetic stripe scanning is used, the film path distance in the direction of travel from the center of the picture aperture to the point at which magnetic sound scanning occurs shall be 28 frames in accordance with American Standard Picture-Sound Separation in 16mm Magnetic Sound Projectors, PH22.112-1958. (See Section 19.)

17.2 *Mechanical Stabilization.* The root-mean-square (rms) value of the total (sum of all frequencies) flutter shall not be greater than 0.25 percent when using a 3000-cycle flutter test film complying with the requirements of American Standard 16mm 3000-Cycle Flutter Test Film, PH22.43-1953.[1] (See Section 19.) Film splices shall not cause any serious disturbance in sound stabilization.

17.3 *Dimensions of Scanning Aperture.* In the plane of optimum focus the scanning light beam shall have a maximum height of 0.0005 inch and a width of 0.071 ± 0.001 inch. [Reference for width: American Standard Photographic Sound Record on 16mm Prints, PH22.41-1957. (See Section 19.)]

17.4 Adjustment of Scanning Beam

17.4.1 *Lateral Adjustment.* Means shall be provided for adjusting the lateral position of the scanning beam so that the projector does not reproduce either signal on a buzz-track test film complying with the requirements of American Standard 16mm Buzz-Track Test Film, PH22.57-1955.[1] (See Section 19.)

17.4.2 Azimuth Adjustment

17.4.2.1 Means shall be provided for adjusting the azimuth of the scanning beam.

17.4.2.2 The azimuth shall be adjusted to secure maximum response using a 7000-cycle test film complying with the requirements of American Standard 16mm Sound-Focusing Test Film, PH22.42-1955.[1] (See Section 19.)

17.4.3 Focus Adjustment

17.4.3.1 Means shall be provided for adjusting the focus of the sound optics to

* For this test a film available from the Society of Motion Picture and Television Engineers is recommended, although many title strips will also be satisfactory.

[1] Test films in accordance with these standards are available from the Society of Motion Picture and Television Engineers.

NOT APPROVED

place the plane of optimum focus in coincidence with the emulsion plane.

17.4.3.2 Focus shall be adjusted to secure maximum response using a test film complying with the requirements of American Standard 16mm Sound-Focusing Test Film, PH22.42-1955. (See Section 19.)

17.4.3.3 Means shall be provided for rapidly and accurately shifting the plane of optimum focus to coincide with the emulsion position on either side of the film.

17.5 *Light Distribution.* The light distribution in the scanning aperture shall be sufficiently uniform to produce a signal across a resistive load at the output of the preamplifier which is constant within ± 1.5 db when reproducing a Scanning-Beam Uniformity Test Film complying with the requirements of American Standard Scanning-Beam Uniformity Test Film for 16-Millimeter Motion-Picture Sound Reproducers (Laboratory Type), Z22.80-1950, or American Standard Scanning-Beam Uniformity Test Film for 16-Millimeter Motion-Picture Sound Reproducers (Service Type), Z22.81-1950.[2] (See Section 19.)

17.6 Exciter Lamp

17.6.1 The exciter lamp shall be so mounted as to permit rapid replacement.

17.6.2 It is not desirable that uniformity of illumination in the scanning aperture be critically dependent upon exciter lamp position. If this condition exists, means shall be provided for independent horizontal and vertical adjustment of the exciter lamp position.

17.6.3 The exciter lamp shall be a prefocused type, unless the lamp holder is a replaceable type equipped with adequate adjustments which can be preset and a spare lamp holder is provided.

17.6.4 The exciter lamp shall be operated at all times within any applicable ratings established by the manufacturer of the lamp.

[2] Test films in accordance with these standards are available from the Society of Motion Picture and Television Engineers.

18. Sound Amplification System

Any statement of sound-reproduction characteristics must necessarily cover the performance of a preamplifier which is specifically designed as a component of the projector. However, it is not essential that all or even any part of the preamplifier be included in the projector structure. Wherever they are mounted, all parts of the preamplifier should be readily accessible.

18.1 *Output Impedance.* There shall be balanced output impedances of 600 and 150 ohms available.

18.2 Output level

18.2.1 *Standard.* The output level shall be -10 decibels referred to 1 milliwatt (dbm).

18.2.2 *Method of Measurement.* This level shall be produced using level test film complying with the requirements of American Standard 16mm 400-Cycle Signal-Level Test Film, PH22.45-1955.[3] (See Section 19.)

18.2.3 A gain normalization control shall be provided having sufficient range to insure compliance with the above standard for any normal combination of exciter lamp, photocell and amplifier tubes.

18.3 Frequency Response

18.3.1 If the frequency response from film to output is fixed, it shall be flat within ± 1 db from 50 to 6000 cycles per second. If tone controls are provided in the preamplifier, their range of adjustment shall include this response.

18.3.2 *Method of Measurement* The frequency response shall be determined by means of a multifrequency test film complying with American Standard 16mm Multifrequency Test Film, PH22.44-1953.[3] (See Section 19.) The amplitude of response shall be measured across a resistance load at the output of the preamplifier. The frequency response shall be determined with standard gain. (See 18.2.)

[3] A test film in accordance with this standard is available from the Society of Motion Picture and Television Engineers.

18.4 *Distortion.* Although it is desirable to state a distortion standard which will cover the photocell as well as the preamplifier, a method of measurement which will accomplish this result is not known. Consequently, the present standard covers only distortion in the preamplifier.

18.4.1 *Standard.* Total harmonic distortion in the preamplifier at standard output level shall not exceed 0.5 percent in the input signal range from 50 to 6000 cycles per second.

18.4.2 *Method of Measurement.* Test signals from an oscillator shall be applied at the photocell input of the preamplifier and distortion shall be measured with a distortion analyzer at the preamplifier output at standard output level.

18.5 Preamplifier Noise Level

18.5.1 *Standard.* The noise level of the preamplifier shall be at least -65 dbm.

18.5.2 *Method of Measurement.* The noise level of the preamplifier shall be measured at standard gain (see 18.2), with the projector running, the exciter lamp energized and no light entering the photocell.

18.6 Over-all Noise Level

18.6.1 *Standard.* The over-all noise level shall be at least -55 dbm.

18.6.2 *Method of Measurement.* The overall noise level shall be measured at standard gain (see 18.2), with the projector running, the exciter lamp energized and no film in the machine.

19. Revisions of American Standards Referred to in This Document

When the following American Standards referred to in this document are superseded by a revision approved by the American Standards Association, Incorporated, the revision shall apply:

PH22.8-1957, American Standard Projected Image Area of 16mm Motion-Picture Film.

PH22.11-1953, American Standard for 16-Millimeter Motion-Picture Projection Reels.

PH22.41-1957, American Standard Photographic Sound Record on 16mm Prints.

PH22.42-1955, American Standard 16mm Sound-Focusing Test Film.

PH22.43-1953, American Standard 16mm 3000-Cycle Flutter Test Film.

PH22.44-1953, American Standard 16mm Multifrequency Test Film.

PH22.45-1955, American Standard 16mm 400-Cycle Signal-Level Test Film.

PH22.53-1953, American Standard Method of Determining Resolving Power of 16mm Motion-Picture Projector Lenses.

PH22.57-1955, American Standard 16mm Buzz-Track Test Film.

PH22.112-1958, American Standard Picture-Sound Separation in 16mm Magnetic Sound Projectors.

Z22.80-1950, American Standard Scanning-Beam Uniformity Test Film for 16-Millimeter Motion-Picture Sound Reproducers (Laboratory Type).

Z22.81-1950, American Standard Scanning-Beam Uniformity Test Film for 16-Millimeter Motion-Picture Sound Reproducers (Service Type).

Appendix

(This Appendix is not a part of Proposed American Standard 16mm Television Intermittent Projector for Vidicon Camera Operation, PH22.125, but is included to facilitate its use.)

Since jump and weave are mechanical characteristics of the projector and are independent of image magnification, it is recommended that both be measured with the greatest magnification that will still give a sufficiently bright image for direct observation.

Jump and weave are usually measured by projecting a test film which is a positive print having a black background with all copy white or transparent. The film stock used has high resolution and has been accurately perforated on both edges, one frame-interval at a time, so that the steadiness of each frame will be in respect to its perforations. Film of this type may be obtained from the Society of Motion Picture and Television Engineers.

89th SMPTE Convention

Hotel King Edward-Sheraton

TORONTO, CANADA

May 7 – 12, 1961

Theme: International Achievements in Motion Pictures and Television

Program Chairman: **Rodger J. Ross,** Canadian Broadcasting Corp., 354 Jarvis St., Toronto, Ontario, Canada

Topics and Topic Chairmen

Cinematography: **Ivor Lomas,** Graphic Films Ltd., 19 Fairmont Ave., Ottawa, Ont.

Film and Television in Education: **Rolf Epstein,** Sound Div., National Film Board of Canada, P.O. Box 6100, Montreal, P.Q.

Film-Projection Equipment and Practices: **Eric C. Johnson,** Motion Picture Film Dept., Eastman Kodak Co., 343 State St., Rochester 4, N. Y.

Image-Forming Systems: **Allan L. Sorem,** Research Labs., Eastman Kodak Co., Kodak Park, Rochester 4, N. Y.

Instrumentation and High-Speed Photography: **Morton Sultanoff,** Ballistics Research Labs., Aberdeen Proving Ground, Md.

Laboratory Practices: **Harold Jones,** Professional Motion Picture Dept., Ansco, Binghamton, N. Y.

New Developments in 8mm: **John Flory,** Advisor, Nontheatrical Films, Eastman Kodak Co., 343 State St., Rochester 4, N. Y.

Sound Recording and Reproduction: **Kenneth MacKenzie,** McCurdy Radio Industries, Ltd., 22 Front St., Toronto, Ont.

Standards and Standardization: **Charles Anderson,** Ampex Professional Products Co., Box 3000, Redwood City, Calif.

Television Equipment: **R. E. Putman,** Industrial Electronics Div., General Electric Co., Syracuse, N. Y.

Television Film: **John Stott,** Eastman Kodak Co., 343 State St., Rochester 4, N. Y.

Television Recording: **Helmut Berger,** Robert Lawrence Productions (Canada) Ltd., 38 Yorkville St., Toronto, Ont.

Television Studio Practices and Station Operation: **Harold Wright,** Canadian Broadcasting Corp., 354 Jarvis St., Toronto, Ont.

Not without precedent, for the SMPE Fall Convention in 1923 was held in Ottawa, Canada, but certainly a noteworthy event is the selection for a Convention site outside of the United States. The theme, "International Achievements in Motion Pictures and Television" is, indeed, appropriate, relating not only to the Convention City, but to the ever-widening interests of the Society. Toronto (pop. $1\frac{1}{2}$ million) is considered the major center of the motion-picture and television industries in Canada. A busy industrial city, it also has much of interest historically and culturally. It is the home of the Royal Conservatory of Music, Ontario College of Art and the Royal Ontario Museum, famous for a magnificent Chinese collection.

A great deal of productive planning has been and is going into the assembling and coordination of the multiplicity of diverse factors essential to the construction of an outstanding Convention.

Traditionally this initial announcement is prefaced by an admonition to authors to be prompt and diligent in communicating with the Topic Chairman whose Topic seems best to fit the subject of the paper. If the author is uncertain as to the most suitable topic he should communicate with the Program Chairman. Offers of papers may also be made in the United States through the Regional Chairmen of the Papers Committee and in other countries through the appropriate National Regional Chairman. These are listed in the Directory for Members (April 1960 *Journal*, Pt. II, p. 9).

Equipment Exhibit

In addition to the Technical Session Topics there will be a special session devoted to equipment papers and demonstrations. The Chairman for this session is Kenneth S. Oakley, Professional Div., Bell & Howell Canada, Ltd., 88 Industry St., Toronto 15, Ont. Questions about exhibits and particularly questions relating to Customs regulations may be referred to Mr. Oakley. For the convenience of exhibitors the Society has appointed two official Customs Brokers who will contact exhibitors and provide necessary forms with detailed instructions. Also, an Exhibitors Manual is being prepared containing details of the booths, power supply, transportation and labor, and also describing in detail a simple procedure for the movement of exhibits through the Canadian Customs.

Local Arrangements

Much of the "work-type" work—meaning endless attention to details and the overcoming of minor and major obstacles—devolves upon the Local Arrangements Chairmen. To each Chairman is entrusted the responsibility of a specific area of Convention planning and accomplishment; anyone who has undertaken a comparable task can testify to the difficulties and frustrations that often beset the path of the most diligent and dedicated worker. It speaks well for the caliber of Local Arrangements Chairmen that the successful completion of their planning is recognized a priori. Those responsible for the 89th Convention are:

Local Arrangements Chairman: **Gerald G. Graham,** National Film Board of Canada, Post Office Box 6100, Montreal 3, P.Q.

Administrative Assistants: **Norman Olding,** Canadian Broadcasting Corp., 5253 Decarie Blvd., Montreal, P.Q., **E. Wally Hamilton,** Trans-Canada Films Ltd., 1212 Burrard St., Vancouver 1, B. C., **A. H. Simmons,** Braun of Canada Equipment Ltd., 35 Haas Rd., Rexdale, Ont., **R. R. Epstein,** National Film Board of Canada, P.O. Box 6100, Montreal 3, P.Q., **Lou T. Wise,** Photo Department Supervisor, Avro Aircraft Ltd., Box 4004, Terminal A, Toronto, Ont.

Auditors: **Jim Bach,** Cinesound Ltd., 553 Rogers Rd., Toronto, Ont., **Don Clayton,** Cinesound Ltd., 553 Rogers Rd., Toronto, Ont.

Vice-Chairman: **Roger Beaudry,** Pathe-DeLuxe of Canada Ltd., 9 Brockhouse Rd., Toronto 14, Ont.

Motion-Picture Short Subjects: **Ralph Ellis,** Freemantle of Canada Ltd., 17 Dundonald St., Toronto 5, Ont.

Hotel Arrangements: **Harold Bibby,** Canadian Kodak Sales Ltd., 447 Jarvis St., Toronto 5, Ont.

Registration: **Don Dixon,** Canadian Kodak Sales Ltd. Toronto 15, Ont.

Publicity: **Gordon Fraser:** Christopher Smith II Film Labs., 30 Wellington St., East, Toronto, Ont.

Membership: **Jim Buist,** Minnesota Mining and Manufacturing Co. of Canada, Oxford St., East, London, Ont.

Banquet: **Arthur Chetwynd,** Chetwynd Films Ltd., 447 Jarvis St., Toronto, 5, Ont.

Luncheon: **Spence Caldwell,** S. W. Caldwell Ltd., 447 Jarvis St., Toronto 5, Ont.

Public Address, Recording and Projection: **Al Turnbull,** General Sound and Theatre Equipment Ltd., 861 Bay St., Toronto, Ont.

Exhibits: **Kenneth S. Oakley,** Bell & Howell Canada Ltd., 88 Industry St., Toronto 15, Ont.

Hospitality: **Mrs. A. L. Clark,** Alex L. Clark, Ltd., 3751 Bloor St., West, Islington, Ont.

Ladies Program: **Frank Tate,** Photo Importing Agencies Ltd., 345 Adelaide St., West, Toronto, Ont.

Co-Hostesses: **Mrs. S. W. Caldwell,** 6 Dale Ave., Toronto, Ont., and **Mrs. F. L. Tate,** 32 Watson Ave., Oakville, Ont.

Transportation: **Ron Ringler,** DuPont of Canada Ltd., 85 Eglinton St., East, Toronto 12, Ont.

Special Assignments: **R. S. Rekert,** National Film Board of Canada, P.O. Box 6100, Montreal 3, P.Q.

Education, Industry News

The SMPTE lecture series on Motion Picture Techniques presented by the Chicago Section in cooperation with Northwestern University began October 26 with a general survey of the field. Ten non-credit, illustrated evening lectures to cover all phases of the subject will be presented by Dr. H. C. Wohlrab, of Bell & Howell Co., assisted by selected experts. Field trips will be part of the program. SMPTE members and Northwestern students are eligible for the course and interested persons in the industry will be accepted for the course as long as space permits. Application for enrollment should be made to Motion Picture Techniques, School of Speech, Northwestern University, Evanston, Ill. The Registration fee is $5.00. Checks should be made payable to SMPTE. Dates and subjects of lectures are: Oct. 26, General Survey; Nov. 9, Cameras Optics, Dimensions; Dec. 7, Film Emulsions, Standards, Photochemistry; Jan. 11, 1961, Processing and Printing; Feb. 1, Sound; Feb. 22, Motion-Picture Studio, On Stage; Mar. 8, Motion-Picture Studio, Behind Stage; Apr. 5, Theater and Projection; May 3, Film in TV, News, Videotape; May 24, Special Applications. A descriptive brochure is available from Motion Picture Techniques, School of Speech, Northwestern University, Evanston, Ill.

Plans for a lecture program of interest to managerial and nontechnical personnel in the field of audio-video recording, sponsored by the Subcommittee for Education in Audio-Video Recording, have been announced by the East Coast Division of the SMPTE Education Committee. Tentatively scheduled for December, the date on which the program will be given and the names of the speakers will be announced. The Subcommittee also plans a series of technical lectures of special interest to operating technicians and engineers beginning early in 1961.

The East Coast Division has worked with the New York City College Student Chapter by arranging tours to Reeves Sound Studios, Movielab Film Labs, DeLuxe Labs, Warner Theater, and similar installations. The East Coast Division was also instrumental in arranging presentation to the Chapter of 60 rolls of film donated by Christian Thiers on behalf of Gevaert Company. The film was used to carry out a Chapter project.

Other activities in progress include preparation by the East Coast Subcommittee for Education of Sound Technicians of transcripts of lectures, presented during a former study course, for publication.

An intensified 10-day short course for managers and engineers is offered by the University of California, Los Angeles, January 23 through February 2, 1961. This is the seventh year this course has been given. Participants will have a choice of 23 subjects being taught by 30 professors, industry specialists and managerial consultants. There are no formal educational requirements but the enrollment is limited. The wide selection of subjects includes Mathematical Bases for Decision and Programing in Industry; Electronic Data Processing for Business and Industry; Engineering and Research Administration; Industrial Statistics and Quality Control and many others related to engineering and management. Fee for the course is $450. Additional information may be obtained from Reno R. Cole, Coordi-

nator, Engineering and Management Course, College of Engineering, University of California, Los Angeles 24.

Hidemitsu Seki and Akira Kodama, authors of "New Type of Make-Up Material for Color Motion Pictures and Color Television" published in the June 1960 *Journal* (pp. 414–420) were presented with an Award at the 13th General Meeting of the Motion Picture Engineering Society of Japan, Sankei-Kaikan, 3 Otemachi-I, Rm. 721, Chiyodaku Tokyo, Japan, held May 23 in Tokyo, for the development of the material described in the paper. Three other Awards and three "Praises" were presented at the same meeting, according to a report in the June 1960 issue of *Motion-Picture Engineering* (the journal of the Motion Picture Engineering Society of Japan). Awards were presented to Hiroshi Kimura for a survey on air pollution in motion-picture theaters; Hideo Mori of Hokushin Electric Works for the development of a 16mm xenon projector; and Shinro Fukada of Fuji Photo Film Co. for research in the manufacturing of 16mm negative film for TV. Praises were presented to Hiroshi Fukada of Rikagsku Seiki Co. for the development of an automatic opaque projector; T. Kuriyama of Nippon Onkyo Seik Co. for the development of theatrical equipments for 70mm film exhibition; and Kenjiro Takayanagi of Victor Co. for the development of a 35mm color/black-and-white projector.

Membership in the Japanese Society is rapidly climbing toward the 3000 mark with 2600 active members, 130 associates, 25 foreign members, and 125 supporting member companies reported as of July, 1959.

George Lewin, recipient of the Samuel L. Warner Memorial Award in 1958 and the Journal Award the same year for his two papers on "The Infrared Transparency of Magnetic Tracks," has been granted U.S. Patent No. 2,295,971 (1960) for Multiple Soundtracks, based on the principle discovered by Mr. Lewin and described in the two award-winning papers. The discovery that infrared light can penetrate a magnetic soundtrack led to the superimposing of a magnetic stripe onto an optical soundtrack without interfering with its reproduction. This stripe can be used to record and reproduce a different soundtrack. This principle may be applied to bilingual motion-picture prints, films with stereophonic soundtracks, and in similar uses. The possibility of three soundtracks with the optical track sandwiched between two magnetic tracks is included in the Patent. To utilize this principle a projector must have an infrared-sensitive photocell. The JAN projector, which has this type of cell, helped put Mr. Lewin on the "track" of multiple soundtracks.

The Society for Film Research was organized in January, 1959, in Great Britain for the purpose of encouraging research in the history of the cinema "in Britain especially, but also elsewhere" and to accumulate facts that would serve as a basis of the establishment of critical standards. The organization's interests cover the whole field of the cinema "from the development of optical toys and apparatus in the 19th Century to the Free Cinema and Nouvelle Vague movements in the 1950s." Chairman of the Society is John Minchinton; Hon. Treasurer is Ronald S. Raddon; and Hon. Secretary is Rosemary Heaword, 3 Hollybrake, Bull Lane, Chislehurst, Kent, England. A journal, *Cinema Studies*, is published twice a year, and a Newsletter is sent out at intervals. Members of the new organization are eager to correspond with persons of similar interests and to learn of similar organizations. Miss Heaword, in a letter to the Editor of the *Journal*, stressed that "the technical aspects of film history are just as much of interest to us as the artistic and economic and sociological ones."

The 11th National Conference on Standards sponsored by the American Standards Assn. was held October 25–27 at the Sheraton-Atlantic Hotel, New York. Ten sessions were held, covering many phases of standards activities. The first session reviewed previous accomplishments. Other sessions covered Policy Direction and Programing; Defense Standards Operations; How ASA Serves Company Standards Needs; Creating Standards Programs in New Areas (two sessions); Value Analysis as a Basis of Standardization; Quality Standards in Manufacturing; The Executive Viewpoint on Standards; and Accomplishments, Developments, and Need for Standards Activities in the Building Industry.

Gevaert serves the motion picture industry

Whatever sensitized materials you require, Gevaert makes exactly the product you need. Our range of products for the professional motion picture industry includes black-and-white and color materials, including negative-positive and reversal, image and sound.

Due to leadership in research and development on all new and improved techniques and applications, Gevaert films fulfill the most exacting requirements of contemporary motion picture techniques.

Gevaert films for all purposes

Negative Films   Duplicating Films
Positive Films   Sound Films   Reversal Films
Gevacolor Color Films
Magnetic Films   Television Films

GEVAERT

GEVAERT Offers a complete line of quality photographic materials

GEVAERT PHOTO-PRODUCTEN N.V., 27 SEPTESTRAAT, MORTSEL (ANTWERP) BELGIUM

In the U. S.: The Gevaert Company of America, Inc., 321 West 54 Street, New York 19
In Canada: Photo Importing Agencies Ltd., 345 Adelaide Street West, Toronto 2B, Ontario

Sidney Meyers, well-known screen director, has joined the faculty of the Institute of Film Techniques of the City College of New York, according to an announcement by Yael Woll, Director of the Institute. He is presently conducting an evening course in advanced editing which will extend through the Fall term. Mr. Meyer served as the only American juror at the Venice Film Festival. Among the many films directed by him is the award-winning *The Quiet Ones.*

The 1961 National Conference of the Society of Photographic Scientists and Engineers will be held May 22–26 at the Arlington Hotel, Binghamton, N.Y. The main theme of the conference will be the scientific and engineering aspects of color photography. Papers on black-and-white photography will also be presented. Specific areas to be covered in the program include Color Perception and Color Photography; Color Photographic Systems and Processes; Structure of the Gold Image; Color Sensitometry and Densitometry; Color Cameras, Printers and Processing Equipment; Color Photography for Recording Purposes in Science and Engineering.

More than 200,000 persons viewed photographic exhibits shown by 550 firms at the Photokina held in Cologne, Germany, September 24 through October 2. Seventeen countries were represented at the exhibitions marking the 10th anniversary of the Photokina. Some interesting trends were apparent both in the countries represented and the equipments exhibited. Sixteen countries other than Germany were represented by 199 of the 550 exhibitors, an increase of 14% over the number of foreign firms taking part in the 1958 Photokina. There were considerably more visitors from the Far East and the Middle East and from Africa than in previous years.

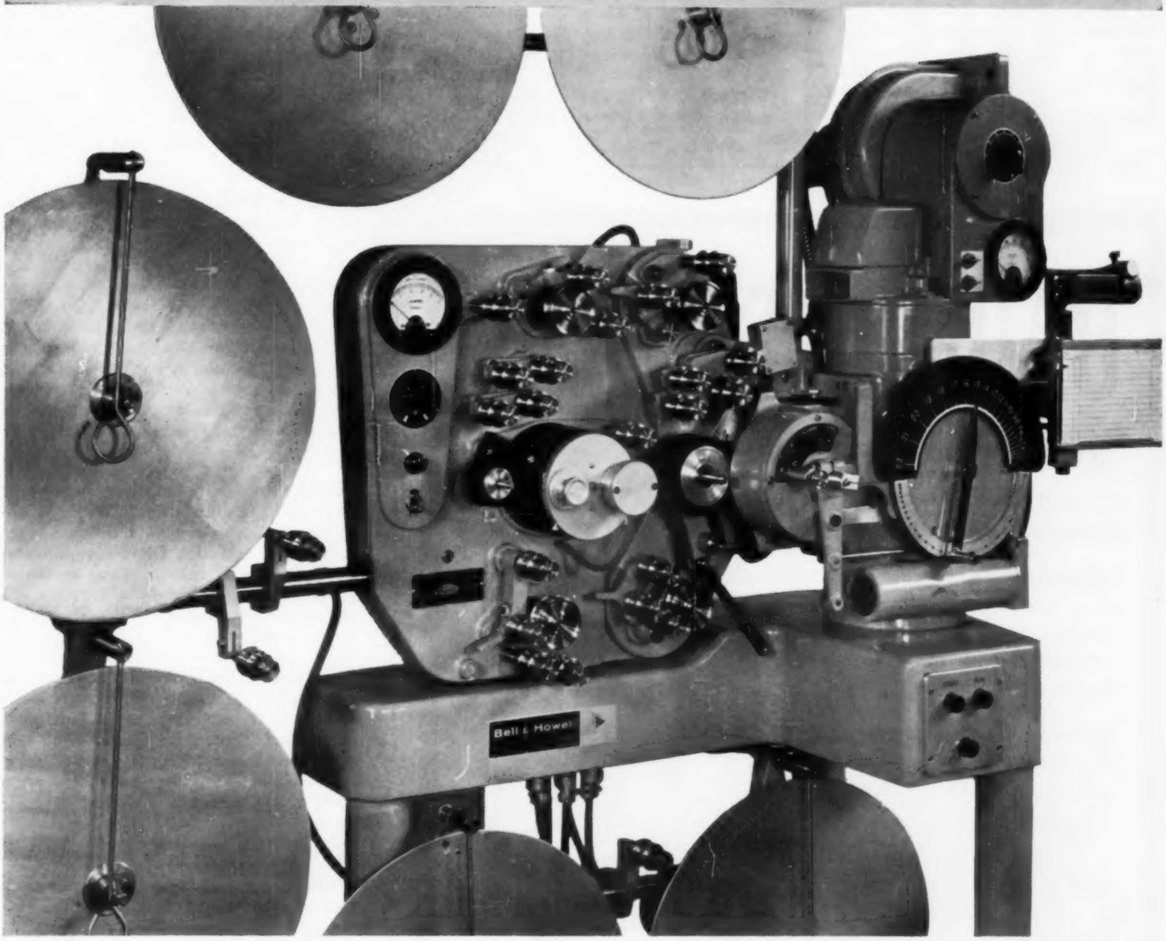
One of the most notable trends evident in the exhibits was the emphasis on automatic exposure control and on 8mm motion-picture cameras. Also, a number of interesting equipments for scientific and industrial applications, such as radiography, were shown.

The III^e Biennale Internationale Photo-Cinéma-Optique Exposition will be held April 15–24, 1961, at the Palais des Expositions (C.N.I.T.) in Paris under the sponsorship of the Comité Française des Expositions. Specially organized exhibitions planned to cover all phases of photography will be displayed at the new Exposition Center at the Rond-Point de la Défense. The first of these Expositions was held in Paris in May, 1955; the second was in Washington, D.C., in April, 1957. Further information is available from III^e Biennale Internationale Photo-Cinéma-Optique, 15 Rue de Bellechasse, Paris 7.

The Sixth Conference on Radio Interference Reduction and Electronic Compatibility was held October 4–6 at the Museum of Science and Industry, Chicago. Sponsored jointly by the Army, Navy and Airforce, the Conference was conducted by the Armour Research Foundation of Illinois Institute of Technology in cooperation with the Professional Group on Radio Frequency Interference of the Institute of Radio Engineers. Sessions included presentations on Missile and Space Considerations, Antenna Measurement Prediction Methods, Shielding, Instrumentation, and related subjects.

An address on darkroom lighting systems was given before the Illuminating Engineering Society (1860 Broadway, New York) at a recent Conference in Pittsburgh, by Herbert S. Glick of Eastman Kodak Co. Various purposes of darkroom lighting were discussed and factors to be considered in lighting systems were outlined. These included sensitivity of the eye, sensitivity of the materials, energy distribution of the light source, and the time of exposure. Mr. Glick also discussed proper placement of lights for production and maintenance and told of the properties of filters and light sources. In discussing the peculiarities of human vision he noted the Purkinje effect relating to the sensitivity of the eye to blue light. This effect occurs because the eye has two light-sensitive organs, the cones, responsible for vision in fairly high levels, and the rods for low-level illumination. In very dim light the eye uses only the rods and has greater sensitivity to blue.

An Announcement
of interest to laboratory people everywhere



Through these pages we'd like to tell you of a new organization, whose sole function is to provide the motion picture laboratories of the world with consistently better printing equipment.

Where ever—and for whatever purpose—motion picture film is copied, duplicated or printed, we stand ready to aid in this process.

As an example of our forward engineering program, we are proud to show you the all new **PETERSON** Sound Head.

Designed especially for the new, steady, Bell & Howell 16MM "JM" Printer, this new Sound Printing Head produces higher quality photographic sound than any other such attachment on the market. Write for details, or if you already have a "JM," send us a test track and we'll make you a demonstration print—that's how positive we are of our quality! The price? A modest $2,695.00.

Do you wonder what happens to profits when you make your own replacement parts for printers—and bury the costs in overhead? **PETERSON** can supply all your needs for Depue, Motion Picture Printing Equipment and Bell & Howell spare parts.

why not try Peterson
8109 N. Ridgeway Ave.
Skokie, Illinois

Your response to our first announcement last month was extremely encouraging. Participation at the 5th International Congress on High-Speed Photography has delayed the preparation of a new ad, so, to both our old and new friends, keep remembering ***Peterson*** *until we meet again.*

The 1961 American Film Festival will be held April 19–22 at the Barbizon-Plaza Hotel, New York. Sponsored annually by the Educational Film Library Association, all 16mm films and 35mm film strips produced during the preceding calendar year are eligible for competition. Blue Ribbon Awards are presented to outstanding films and filmstrips in 34 categories. Emily S. Jones, Administrative Director of EFLA, has announced that entry blanks and information about the Festival will shortly be mailed to film producers, sponsors and distributors. Additional information is available from EFLA, 250 West 57 St., New York 19.

Expansion of the contract manufacturing service facilities of Ansco, Division of General Aniline and Film Corp., Binghamton, N.Y., to include the microwave field has been announced. Harmonic generators are now in production and planning is underway for the manufacture of wave guides and other equipments related to the communications field.

New owner of television station KBAK-TV, Bakersfield, Calif., is Reeves Broadcasting and Development Corp., 304 East 44 St., New York, it was announced by Hazard E. Reeves, President of the corporation. Former owner is Bakersfield Broadcasting Co. Estimated purchase price is well over $1 million which includes the cost of moving the broadcasting tower to a site 7000 ft above sea level from its previous location at 600-ft elevation to increase the station's area coverage. The station operates on UHF Channel 29.

Motion Pictures, Inc., a Dallas firm, has purchased the building and physical facilities of Coffman Film Co., Dallas. All its operations, including laboratory, production and administrative are now located under one roof at 4519 Maple Ave., Dallas. The firm now offers complete 35mm and 16mm film services including sound, editing and animation. It has a 48 by 86-ft sound stage.

A new Industrial Products Subdivision has been created within Avco Research and Advanced Development Division, 201 Lowell St., Wilmington, Mass., for the development and marketing of materials and equipments associated with high-temperature technology and environmental simulation. Robert A. Hawkins has been appointed Director of Products in charge of the new subdivision. The new appointment is in addition to his present post of Manager of the Quality and Reliability Department.

General Precision, Inc., has opened new offices at 724 Fourteenth St., N.W., Washington, D.C., to provide additional space for its GPL and Link Division representatives. General Precision, Inc., personnel and representatives of other divisions will remain at the offices at 777 Fourteenth St., N.W., Washington, D.C.

The firm of Fraser Productions is now established in Columbus Towers, San Francisco 11, according to an announcement from Thomas H. Fraser. The new office and technical facilities are planned to accommodate an expanded industrial motion-picture division, a television commercials division and other production operations. Mr. Fraser has acted as an advisory and technical consultant to San Francisco advertising agencies and has instructed advanced courses in TV production as well as producing industrial and public relations films.

Eastern distributor for Rapromatic Processing, an automatic method of developing and fixing film, is Camera Equipment Co., 315 West 43 St., New York 36. The process, developed by Rapromatic, Inc., Oak Drive, Syosset, L.I., N.Y., is based on the use of Raproroll, a chemically presaturated paper which is fitted, in roll form into the magazine or other processor. A mechanical squeezing action at the point of sandwich formation develops and fixes film on contact while the camera is in operation. The firm has also recently announced a portable processer, the Rapromatic 400, which is used for processing exposed film. Fitted with a hand crank or motorized it is suggested for field processing of TV news photography or in areas where water or power may be limited. Based on the same principle as the method used for developing simultaneously with exposure, the portable processer weighs 30 lb and is said to be capable of processing from 1 to 400 ft of

either 16mm or 35mm photographic material at an average speed of 50 ft/min.

Protective devices installed by J. A. Tanney, President of S.O.S Cinema Supply Corp., 602 W. 52 St., New York 19, following the second daylight robbery of the premises by armed bandits within the year, include a closed-circuit TV camera focused at the entrance, a radio alert system to broadcast the "S.O.S. in distress" signal, a loud burglar alarm at the street door, and a wire cage with electrically operated door in the foyer. If in the unlikely event that any desperados slip past these watchful electronic marvels, it is planned to install bullet proof glass in the reception room.

The reddish-purple trefoil on a yellow background, generally accepted as the symbol denoting radiation hazard, has been formally approved by the American Standards Association as Radiation Symbol N2.1-1960. This is the first standard to be developed through a sectional committee under the supervision of the Nuclear Standards Board. A similar symbol was first used in 1946 by the University of California Radiation Laboratory. Magenta was selected as the color of the trefoil because it is unusual and because the dye is expensive, thus tending to discourage its use for other purposes. The background, originally light blue, was changed to yellow because of the attention-getting properties of this color.

Shipboard Television facilities, including equipment for coordinated internal and off-air television service have been installed in two British passenger ships, the Canberra, of the P & O Line, and the Oriana, of the Orient Line. The installation provides for the reception of broadcasts with the 405-line system (British); the 625-line system (from Australia and most of Europe); and the 525-line system (United States, Canada and Japan). Incoming broadcasts are processed for suitability in a central television control room before distribution to the ship's receivers. Processing equipment includes two Marconi vidicon camera channels, which also form part of the closed-circuit installation.

Kling Photo Corp., New York, has announced the purchase of the building at 826 Cole Ave., Hollywood, formerly occupied by Polaroid Corp., to be used as the new quarters of the firm's West Coast Branch. The building has a floor area of 6000 sq ft, is fully air conditioned and has its own truck ramp and a large parking lot.

A $190,000 expansion of the educational television system in the Anaheim, Calif., school district has been contracted to Hallamore Electronics Division of Seigler Corp. Under terms of the contract the firm will install equipment in additional classrooms of schools presently included in the system as well as in three new schools. Under an earlier contract the firm supplied equipment for the initial installation of educational television at Anaheim. The cables were installed by Pacific Telephone and Telegraph Co. The project was described in a paper by Max P. Beere, presented at the 1960 SMPTE Fall Convention at Los Angeles, "Transmission Facilities for the Anaheim Educational Television Project."

A contract for installation of closed-circuit TV systems for the Titan missile program has been announced by the Siegler Corporation's Hallamore Electronics Division. The contract was received from the Martin Company's Denver Division. The equipment will include transistorized TV cameras which will be used in monitoring the launching of the Titans from underground silos at Vandenberg Air Force Base, Calif.

Neal K. McNaughten has been appointed staff Vice-President of Ampex Corp. and Marketing Activities Consultant for three divisions of the firm: Professional Products Co., Audio Co., and Ampex International. He is succeed as Manager of Ampex Professional Products Co. by Leonard E. Good who was formerly Corporate Staff Director of Operations Services for Ampex Corp. The appointment of Harold S. Salzman as Marketing Manager of the Professional Products Co. has also been announced. He was formerly associated with American Telephone and Telegraph Co. Mr. McNaughten has been with Ampex Corp. since 1957 and Mr. Good has been with the firm since 1959.

R. N. Saitta has been appointed representative for Gevaert Company of America Inc.,

with headquarters at the firm's Southwest District Office in Dallas. In his new position he will handle general photographic accounts in Texas and Lousiana as well as handling sales and service for Gevaert microfilms and motion-picture films.

Reuben S. Siegel has been appointed Senior Project Engineer in the Photo Development section at Mergenthaler Linotype Co., Brooklyn, N.Y. Mr. Siegel was formerly Supervisory Chemist at L. B. Russel Chemicals, Inc., Long Island City, N.Y.

Aubrey Harris who has been Technical Sales and Service representative in Europe for the Ampex Video Tape Recorder has been given a new appointment with the newly established Ampex International Engineering Dept., Redwood City, Calif. The function of the new department is to investigate the problems involved in the operation of the television tape recorders on television standards other than those of the United States.

Leaflets describing viewers and slide projectors in a wide range of sizes and prices are available from Tel-A-Story, Inc., 523 Main St., Davenport, Ia. Used for sales presentations, window displays and similar purposes, some of the models are equipped with sound. Costs range from $39.75 to $249.50, with accessories at additional costs.

books reviewed

Infrared Radiation

By Henry L. Hackforth, Published (1960) by McGraw-Hill Book Co., 330 West 42 St., New York 36. v-xii + 303 pp. incl. illus., charts, graphs. 6 by 9-in. Price $10.00.

Infrared Radiation presents a good review of elementary principles of infrared physics, of elementary optical systems and of infrared techniques as applied to today's myriad industrial and military problems. It would be necessary, however, to supplement the material presented in this book by a number of more practical topics in the field of infrared instrumentation if one were to arrive at a point where this knowledge could be applied.

Specifically, one of the major problems in the design of an infrared scanning or tracking instrument working in the daytime has always been the suppression of the very intense Earth or cloud backgrounds. Hackforth has included no extensive discussion of the spatial or spectral characteristics of infrared backgrounds and his treatment of space filtering is poor considering the relative excellence of some of the material in the present literature. He makes no mention of electronic image processing techniques such as edge sharpening, pulse length discrimination. etc.

The section of atmospheric absorption is not detailed enough to be usable for practical engineering purposes. There is also a good deal of material on the distribution of water vapor of altitude which might be included with profit. The chapter on optical systems would have been improved by the inclusion of simple formulae for the first order computation of coma and spherical aberration.

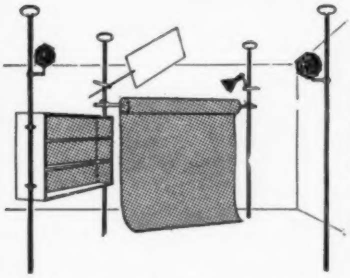
In general, this reviewer would find the book useful for the purpose of introducing people to the subject of infrared, but would, at the same time, find it necessary to supplement this book with more comprehensive material in the above areas.—*T. R. Whitney*, Infrared Systems Dept., Ramo Wooldridge, 8433 Fallbrook Ave., Canoga Park, Calif.

An adhesives properties chart containing information on epoxy adhesives, application, cure times and physical properties is available upon request from Furane Plastics, Inc., 4516 Brazil St., Los Angeles 39. The reverse side of the chart contains such information as test methods, application suggestions and availability.

SERVING THE WORLD'S FINEST FILM MAKERS

New F & B POLE SET

An Easy Way to Hold Things Up . . . Anywhere
Lights • Props • Backgrounds • Mikes
Without Nails or Screws



$34^{95}

per set consisting of:
2—3-piece poles
7—fittings
1—110″ cross bar
Adjustable from 8½′ to 12½′

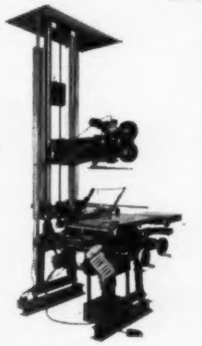
F & B POLE SET is a featherweight, telescoping aluminum column with an expansion spring in the top. Adjust it once to your ceiling height with locking collar. Then just spring it in and out of place as you please. Rubber pads top and bottom protect ceilings and floors . . . can't be knocked over and takes less floor space than a silver dollar. A perfect, mobile, lightweight support for lights. Two POLE SETS with cross piece and fitting can be used to hold a roll of background paper, props, flats, etc. Perfect for location filming.

POLE SET 10½′ to 15′ . . . **$38.95**

Individual Parts:

3 piece Pole with Clamp 8½′ to 12½′ **$8.50 ea**	3 piece Pole with Clamp 10½′ to 15′ **$9.50 ea**	Cross Bar (110″) with 5 fittings **$8.50 ea**

More PORTMAN ANIMATION STANDS Sold To:



- Australian Broadcasting Commission
- Robert Tinfo Technical Animation
- Bay State Film Productions
- Walter Craig Productions
- Ayacucho Cine, Caracas
- KVOS-TV, Vancouver
- Ford Motor Company
- Rembrandt Films
- Ansel Studios
- Corwin Studios
- L & L Animation
- Mayo Clinic
- Slide-O-Chrome

A rugged precision and versatile animation stand that offers more than 40 accessories for special animation and effects.

Prices begin at $1595

AVAILABLE NOW:
New ACME-PORTMAN 16mm-35mm interchangeable camera with ball-bearing mounted cam-rackover. Write for descriptive folder and price list.

ANDRE DEBRIE AIGLONNE *America**

*Now Manufactured in the United States

The new, low-cost **Automatic Daylight Film** Processor embodying the first really new design approach in automatic film processing in years.

- Low initial cost
- Skilled operator not required
- No special installation required
- Develops motion picture, cineradiography and microfilm
- Sprocketless friction drive
- Processes perforated or unperforated film
- Processes very short strips
- Threads automatically
- Replenishes automatically with original solutions

Available in:
35 mm Neg/Pos
35 mm Reversal
16 mm Neg/Pos
16 mm Reversal

Write for detailed brochures and prices

EQUIPMENT LEASING PLANS AVAILABLE ON REQUEST!

FLORMAN & BABB, INC.

68 West 45th Street • New York 36, New York • MUrray Hill 2-2928

Magic Shadows

By Martin Quigley, Jr. Published (1960) by Quigley Publishing Co., 1270 Sixth Ave., New York 20. 191 pp. incl. Appendix I (a Descriptive Chronology) and Appendix II (Bibliography and Acknowledgments). Illus. 6 by 9 in. Price $4.50.

First published in 1948 in a limited edition which has long been out of print, this volume is the first commercial edition of *Magic Shadows*. Written in a popular, easy-to-read style, the book traces the development of motion picture "from Adam to Edison," as stated in the introduction, or from the very emergence of light from the darkness of Chaos to April 23, 1896, when the Vitascope (the Armat-Edison projector) was demonstrated commercially.

Much of the Author's material, particularly in the early chapters is but loosely related to the development of the motion picture. With such a vast period of time to survey in such a limited space, the book is, of necessity, episodic and spotty. This statement is not intended as a criticism of the book. As a framework upon which to hang a delightful collection of anecdotes, interspersed with sober and well-documented fact, it admirably achieves its purpose.

For example, in the chapter on "Kepler and the Stars" (p. 43), the author notes, "In 1600 Kepler became assistant to Tycho Brahe . . . Brahe lost the tip of his nose in a duel, so he wore a gold one, carrying with him cement with which to stick on the tip whenever it fell off." Presumably, a gold-tipped nose did not directly affect the development of the camera obscura, at least the author does not clearly indicate such an influence. But, even though this bit of historical information does not really contribute to the development of the author's theme, we are pleased that he could not resist including it and other such little gems, and we are sure other readers will enjoy the little anecdotes sprinkled throughout the book.

Television in Britain by Gerald Beadle, Director of the Television Service of the British Broadcasting Corp., a 12-page brochure, is a clearly presented and most informative description of the BBC which, it is noted is "in a sense the grandmother of all television services." The brochure describes how BBC is financed, methods of selection and standards of the programs, and notes that BBC would be prepared "to let the average audience go down to one third, maybe even one quarter of the total rather than lower its professional standards." The author then cites statistics to show that rather than losing its audience it "has always been able to pull in the majority mass audience." The material in the brochure was originally contained in an address delivered in New York in January 1960. Copies, or further information, are available from the British Broadcasting Corp., 630 Fifth Ave., New York 20.

The New England Photographer is a new publication designed, according to the foreword in the first (September 1960) issue "to fill a definite need in New England, that of a proper dissemination of news of the photography world as it pertains to our own six states . . . ." It is published monthly by Town Crier Photographers, 364 Middlesex Ave., North Wilmington, Mass. Subscription rate is $2.00 a year. The Editor is Capt. Larz Neilson; Technical Editor is E. Harrison Rideout; Staff Artist is Joseph Landry; and Contributing Editor is Simeon Korisky.

Notes on educational television published in *RCA Educational News* indicate that with the beginning of the Fall term, in educational institutions throughout the country increasing emphasis is being placed on television as a means of instruction. Continental Classroom (NBC) will conduct a course called Contemporary Mathematics, divided into Modern Algebra for the first semester and Probability and Statistics for the second semester. Last year's course on Modern Chemistry will be repeated. This course, broadcast during the 1959–1960 school year had a daily audience of more than 500,000. The use of television in in-class instruction more than doubled in New York City during the 1959–1960 school year. Similar indications are evident in schools and colleges throughout the United States.

Information Processing (600 pp., 8¼ by 11¾-in.) is published jointly by Unesco, Paris; R. Oldenbourg, Munchen; and Butterworth Scientific Publications, Lon-

don, and is available from International Documents Service, Columbia University Press, 2960 Broadway, New York 27. It is priced at $25.00. The book contains the proceedings of the international scientific conference on information processing conducted by Unesco in 1959 and contains the full text of each of the 61 papers written especially for the conference. Summaries of each paper are given in English, French, German and Spanish and summaries of 65 lectures given in various specialized meetings are given in English and French. Topics cover every major aspect of information processing including methods of digital computing; common symbolic language of computers; automatic translation of languages; logical design of computers; and others.

The Proceedings of the Fifth Conference on Magnetism and Magnetic Materials sponsored by the American Institute of Electrical Engineers, in cooperation with the American Physical Society, the Institute of Radio Engineers, the Metallurgical Society of the A.I.M.E. and the Office of Naval Research has been published by McGraw-Hill Book Co., 330 West 42 St., New York 36. The book is 7$\frac{1}{4}$ by 10$\frac{1}{4}$-in., contains 419 pages, and 340 illustrations. It is priced at $10.00. More than 150 articles by eminent scientists and engineers are included, covering recent developments, both theoretical and applied. Topics range in scope from relatively simple test techniques for evaluating materials to advanced research relating to such phenomena as spin wave resonance, "ferromagnetic" and "antiferromagnetic" distortion and spontaneous magnetizations.

National Electrical Code Handbook, 10th ed., has been revised by Frank Stetka, Electrical Field Service Engineer, National Fire Protection Association. Publishers are McGraw-Hill Book Co., 330 West 42 St., New York 36. The book is 5$\frac{3}{8}$ by 8-in., contains 679 pages, 387 illustrations, 53 tables. It is priced at $8.50. Instructions on the handling of all types of electrical wiring and installations in accordance with the National Electrical Code are presented. New features in the 10th edition include reorganization in line with the rearrangement and renumbering of the National Electrical Code, and a number of changes in basic requirements. The *Handbook* also gives modern examples of how to calculate electrical load, number of branch circuits and size of feeders.

The Encyclopaedia Britannica Films, Inc., has announced publication of its 1960–1961 Films, Inc., catalog, *Profile of the American Film*, describing 1500 Hollywood features and shorts available on 16mm film. The films extend from the 1920s into the 1960s and cover major studios and film types. Nearly 200 features are listed for the first time. Many of the earlier films are available for the first time for nontheatrical showing. The films are grouped under film types and sub-types for easy reference. For example the first category is Action and Adventure. Sub-categories are Sea Stories, Jungle Adventure, Horse and Dog Stories, Modern Adventure, and Period Adventure. Many of these films are also listed under other categories, such as Childrens Films. The catalog is enhanced by an article by Dorothy B. Jones, "The Language of Our Time." Miss Jones, a recognized authority on motion pictures, develops the interesting theme that the art of the motion picture is a "new Language," speaking without words, "directly and forcefully." The catalog is available without charge upon request.

A 26-page illustrated catalog offered by the Southwest Film Laboratory, Inc., 3024 Fort Worth Ave., Dallas 11, Texas, plus a data sheet on Triad Color Control, gives a comprehensive explanation of the services offered to producers of 16mm films. Considerable general information of practical interest is also included. Published on the occasion of the Laboratory's 10th anniversary, the illustrations include pictures of the staff with a brief run-down of day-to-day activities.

Lenscreen rear-projection screens are described in a packet of literature available from Polacoat Inc., 9750 Conklin Rd., Blue Ash 42, Ohio. Choice of portable screens ranges from 15 by 15-in. size to 9 by 12-ft. Materials include glass panels of various thicknesses and Plexiglas plastic panels up to 9 by 18-ft in a single piece. Included in the packet of literature is the reprint of a paper by John F. Dreyer on "Operational Characteristics of Rear Projection," first published in the August 1959 *Journal*.

Audio-Visual Equipment Catalog No. 306 offers a brief description of products of Genarco Inc., 97-04 Sutphin Blvd., Jamaica 35, N.Y., including several new models of slide projectors. The catalog is printed in three colors, descriptions of the new models are printed with red ink. The catalog is available upon request.

Equipments produced by Westrex Corp., a division of Litton Industries, are described in two four-page illustrated brochures, available from Leo Call, Sales Supervisor, Westrex Recording Equipment Dept., 6601 Romaine St., Hollywood 38. The RA 1500 series of magnetic film recorders and reproducers is described in one brochure and the RA-1621 multiple unit magnetic rerecorder for motion-picture film is described in the second brochure.

The 1960 Short Form Catalog lists products of Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. Equipments include oscilloscopes, oscillators, digital delay generators, volt meters, electronic counters, waveguide test equipment and similar devices. The catalog is available upon request.

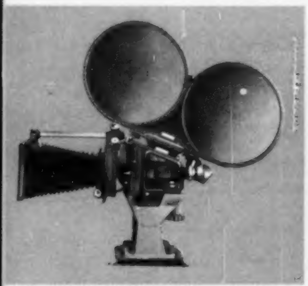
The Bi-Fi, a combination unit for displaying slides and film strips, is described in a leaflet available from Friddel Manufacturing Co., Baytown, Tex. Records of all speeds can be played alone or in combination with other components. The unit includes a tape recorder and slides and film strips can be shown in daylight or at night with or without sound.

ASSURANCES PROFESSIONAL FILM MAKERS DEMAND!

1 THE MANUFACTURER'S LABEL

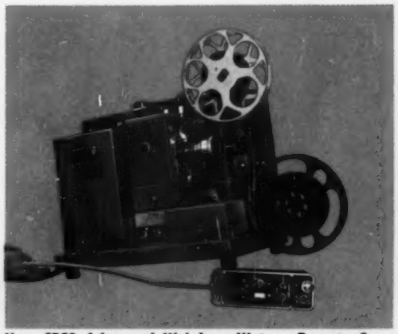
2 CECO'S* GUARANTEED INSPECTION AND STAMP OF APPROVAL

Producers, directors, cameramen, photo-instrumentation and audio-visual engineers come to us for products, equipment repairs, information and ideas because of our know-how and experience as pioneers in the photographic industry. Our staff of engineers and technicians learned on the firing line of practical application.

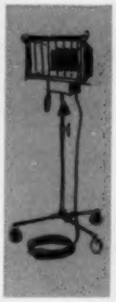


New CECO 1000 foot Magazine for Arriflex 35mm

LOWEL-LITE Kit with Gaffer Tape (A lighting unit which attaches to walls, shelves, stands, pipes . . . most anywhere)

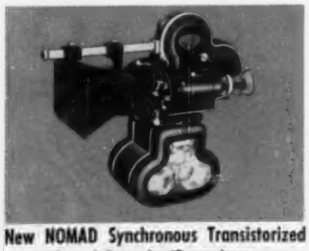


New CECO Advanced Weinberg-Watson Remote Control 16mm Stop Motion Projector (absolutely flickerless). Also CECO 35mm Stop Motion Projectors.



SALES
SERVICE
RENTALS

JARO-Salford Professional Light Exposure Meter with Carrying Case



New NOMAD Synchronous Transistorized Sound Recorder/Reproducer (Lightweight—completely portable)

For full information and price of each product, send this postage-free card now!!!

*CECO — Trademark of Camera Equipment CO., Inc.

CAMERA EQUIPMENT CO., INC. 315 West 43rd St., New York 36, N. Y. JUdson 6-1420

Gentlemen: I am interested in the items checked below. Please rush me more free information on these products

☐ CECO 1000' Magazine for Arri 35	☐ Editing Gloves and Supplies
☐ NOMAD Sound Recorder/Reproducer	☐ MOVISCOP 16mm Film Viewer
☐ JARO-Salford Light Meter	☐ CECO Portable Power Supply
☐ CECO Weinberg-Watson Projector	☐ JEFRONA Cement—GTC-9 Cleaner
☐ LOWEL-LITE Kit	☐ PRECISION Sound Readers
☐ PROSKAR Anamorphic Lens	☐ CECO Film Cleaning Machine
☐ COLORTRAN Lighting Equipment	☐ COLORTRAN Polecats

Name________________ Title________

Firm________________

Address________________

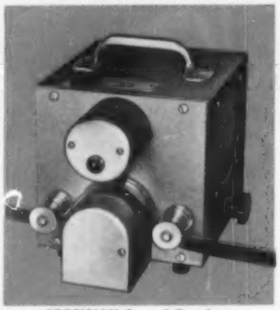
City__________ Zone_____ State______

BEFORE DECIDING TO BUY, RENT, LEASE OR REPAIR YOUR EQUIPMENT, CHECK WITH CECO. ADVICE FROM CECO MEANS MONEY IN YOUR POCKET.

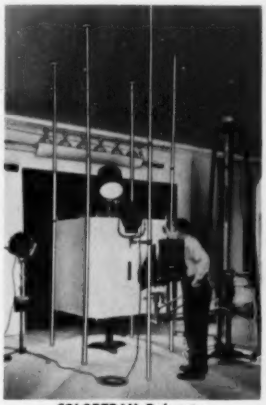
Editing Gloves and Cutting Room Supplies

We provide the same precision repair service for *your* equipment that we give to our own gigantic stock of rental cameras, editing, lighting and other equipment.

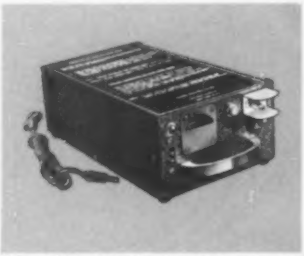
MOVISCOP 16mm Film Viewer



PRECISION Sound Readers (3 models — Optical, Magnetic, Optical-Magnetic combined)

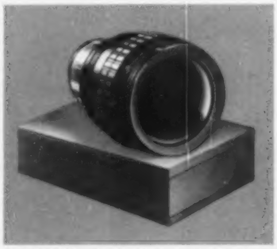


COLORTRAN Polecats (telescoping columns) for Attaching Equipment, Lights, etc. (Various heights available)

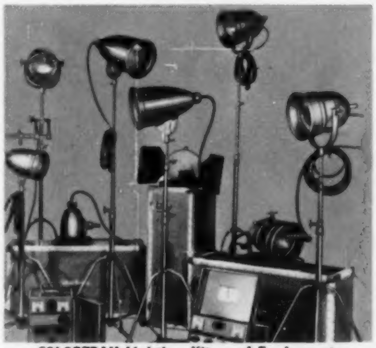


New CECO Portable Power Supply for Auricon Cine-Voice Camera

New CECO Film Cleaner and Cleaning machine



PROSKAR Projection and Photographing Anamorphic Lens for 16mm Cameras and Projectors



COLORTRAN Lighting Kits and Equipment

FIRST CLASS
PERMIT No. 4236
New York, N. Y.
Sec. 34.9, P. L. & R.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

POSTAGE WILL BE PAID BY

CAMERA EQUIPMENT COMPANY, INC.
DEPT. 63, 315 WEST 43RD STREET
NEW YORK 36, N. Y.

In New York:
Camera Equipment Co., Inc.
315 W. 43rd St.
New York 36, N. Y.
JUdson 6-1420

In Florida:
Camera Equipment Co., Inc.
of Florida, 1335 E. 10th Ave.
Hialeah, Florida
TUxedo 8-4604

In Hollywood, California:
Camera Equipment Co., Inc.
6510 Santa Monica Blvd.
Hollywood, California
HOllywood 9-5119

JEFRONA Film Cement & GTC-59 Lens Cleaner

Biographical Note

Albert Narath

(*Edit. Note:* Prof. Dr. Albert Narath is the author of "Oskar Messter and His Work" which appears in the earlier pages of this issue of the *Journal*. The paper is an important addition to the historical record which SMPTE Editorial Vice-President Glenn E. Matthews and the Society's policy through its Historical and Museum Committee have been building. The following has been translated and adapted from *Photo-Technik und -Wirtschaft*, vol. 11: no. 2, pp. 55–56, 1960.)

Prof. Dr. Albert Narath, Director of the Institute for Applied Photochemistry and Film Technology (Institut für angewandte Photochemie und Filmtechnik), President of the German Technical Motion Picture Society (Deutsche Kinotechnische Gesellschaft), observed his 60th birthday, on January 29, 1960. Son of Professor (ordinarius) A. Narath, he was born in Utrecht, in 1900. He attended the Gymnasium in Heidelberg, and at the University there he studied chemistry, physics and mathematics. In 1925, the degree of Doctor of Philosophy was conferred upon him. In the same year, he accepted a position as assistant to Privy Councillor Miethe, at the Institute for Photochemistry of the Technical University of Berlin-Charlottenburg (Institut für Photochemie der Technischen Hochschule Berlin-Charlottenburg). From 1927 on, he worked in the field of sound film, in the AEG research laboratory. He continued with this work in the sound film laboratory of Telefunken, from 1931 to 1941. During this time, he published a large number of technical articles in various fields dealing e.g. with the Kerr Effect, the determination of the Kerr Constant, and the distortions caused by the Kerr cell. For the first time, the photographic transfer (of information) was represented by a general and mathematically exact theory which is valid not only for sound film but also for every photographic system. The various types of sound film recording were investigated (by him) theoretically and experimentally, and a number of new measuring instruments were developed, among which are those for the measurement of the rectifying effect, and those for the photometry of small surface elements. Other work deals with the UKZ (ultrashort time) effect, with resolving power, graininess, methods of diminishing noise, and with the measurement and theoretical interpretation of spectrum distribution. Up to the end of the war, he directed the Research Laboratory of Klangfilm GmbH.

In 1936, he became a member of the faculty of the Technical University of Berlin (Technische Hochschule Berlin) and in 1939 he became lecturer there.

After 1945, he was appointed provisional director of the Institute for Applied Photochemistry at the Technical University of Berlin. At the same time, in the capacity of chief engineer, he built, in Babelsberg, the Research Institute for Cinematography, Sound Film, Photo-Technology and Optics (Forschungsinstitut für Kinematographie, Tonfilmtechnik, Lichttechnik und Optik). In 1948, he was called as associate professor (extraordinarius) and acceded to the chair for Applied Photochemistry and Film Technology. After a full professorship was restored to the chair, the rank accorded it under Privy Councillor Miethe, Dr. Narath became, in 1957, professor and Director of the Institute.

Thereafter, he expanded his field of endeavor and turned also toward the preparation of photographic emulsions, especially those used for nuclear research. But he also carried out in his Institute a number of interesting investigations into plastic emulsions, gelatin, and related problems. Together with H. Lichte he wrote, in 1941, *Physics and Sound Film Technology* (*Physik und Technik des Tonfilms*). The fourth expanded edition of this standard text will appear shortly.

section reports

The Atlanta Section met October 3 at WSB-TV with an attendance of 23. Bill Craig, Southeastern District Manager, Ampex Data Products Co., addressed the group. His subject was: "The Magnetic Recorder as an Instrumentation Device."

During the evening basic magnetic recording theory was discussed and some of the elements of a recording system were illustrated. Differences in design between recording and playback heads were shown. The need for tape of higher quality than that necessary for audio and visual work was emphasized.

Different methods of encoding information and a discussion of the advantages of each were presented. Of particular interest was a description of the various methods used to record multiple signals simultaneously.

Several applications of magnetic tape-recording equipment were shown. The presentation was well illustrated with color slides. A question-and-answer session was held after the meeting.—W. R. Sandell, *Secretary-Treasurer*, c/o Kodak Processing Lab., 4729 Miller Dr., Chamblee, Ga.

The Canadian Section met at the Main Studio of Robert Lawrence Productions in Toronto for the September 15 meeting. Eighty-three members were present.

The leading topic of a two-part program for the evening was a description of the new Thermoplastic recording technique by Peter E. Pashler of the Electron Physics Research Dept., General Electric Co., Schenectady, N.Y. The fundamentals of the process and the equipment involved, were illustrated by the showing of slides, followed by projection of two samples of film which had been pre-recorded at the GE Laboratory in Schenectady. Interesting comparisons were made between photographic film, magnetic tape and thermoplastic film, as to their relative abilities for information, storage and playback.

During the coffee break (Courtesy of Braun of Canada Equipment, Ltd.) Dr. Pashler was kept busy re-running his demonstration films and answering questions.

Following the coffee break, A. Kufluk and Leslie Holmes, both of the Ryerson Institute of Technology in Toronto, collaborated in presenting a description of the facilities and curricula at Ryerson for those preparing to enter the broadcasting or motion-picture industries. Teaching facilities of broad scope have provided Canada with many valuable graduates to these industries since the courses were initiated in 1948.

A pleasant pre-meeting dinner with the speakers and several of the Toronto SMPTE executive group was enjoyed at the Town and Country restaurant.—R. B. MacKenzie, *Chairman*, Program Committee, Toronto Group, Canadian Section, MacKenzie Equipment Co., 433 Jarvis St., Toronto 5, Ont.

The Chicago Section met Tuesday evening, September 20 in the auditorium of the Portland Cement Assn. The meeting was opened by Philip E. Smith, Secretary-Treasurer of the Section, who requested Jack Behrend, Program Chairman, to give a brief indication of the year's programs. After Mr. Behrend's report, the meeting was turned over to the staff of the Portland Cement Assn.

G. T. Kennedy, President, gave a description of the Association and explained how the Educational Film Bureau fits in with the overall work of the organization.

Carl Ziegler, Director of the Educational Film Bureau, described the work and organization of the bureau and its general mode of operation.

Art Mandler of the Film Bureau discussed the details of the various productions made by the Bureau including such phases of work as scene writing, dialogue, settings, emotional audience reaction, etc. His talk was illustrated by some excellent excerpts from various productions made by the Bureau.

Phil Walusek, engineer for the Bureau, described various technical problems and methods relating to sound production, titling, special effects, etc.

The meeting was concluded with an orientation film, prepared by the Bureau, which contained many humorous overtones. All who attended the meeting agreed that it was highly informative and entertaining.—Philip E. Smith, *Secretary-Treasurer*, c/o Eastman Kodak Co., 1712 S. Prairie Ave., Chicago 16, Ill.

The Hollywood Section met on September 20 at ABC Studio A with an attendance of 150. Guest speakers were Neal Keehn, Regional Vice-president, General Film Laboratories, who discussed "The Production of Nontheatrical Films"; and Charles "Cap" Palmer, Head of Parthenon Pictures, whose subject was "Some Specifics on the Production of Business Films."

Mr. Keehn gave an entertaining and informative presentation regarding the production and distribution of nontheatrical films. Excerpts from several film productions were shown to illustrate the broad range of subject matter and production techniques employed in the nontheatrical film field.

As a producer of business films, Mr. Palmer outlined the differences in purpose, production techniques, and distribution of business films as compared to theatrical entertainment films. An excellent demonstration reel, consisting of excerpts from several business films produced by Parthenon Pictures, was shown.—Ralph E. Lovell, *Secretary-Treasurer*, 2554 Prosser Ave., Los Angeles 64.

The Nashville Section met in Memphis on July 16 and toured three new Kodacolor studios there. Twenty-five members were present. Charles Caldwell of WMCT, Memphis; and Frank M. McGeary of Motion Picture Laboratories, served as guides.

The group gathered first on the sound stage of Fotovox, Inc., for chicken dinners supplied by Motion Picture Laboratories, Inc. The sound stage was lighted for shooting and all members present were given Kodacolor negatives for their still cameras so that they could photograph a model. She appeared in various costumes, one a swimming suit. The Chairman asked her to drape herself with the section banner. The result: an interesting advertisement for SMPTE.

The exposed film was rushed to MPL for processing and printing while the group toured the new television studios of WMCT. Charles Caldwell, film director, guided the tour and members reported that his comments added spark to the undertaking.

The next stop was MPL for an inspection tour of the laboratory facilities and a short talk on "Kodacolor" by Frank McGeary. The film shot at Fotovox was ready and the members saw the results of their own photography on the medium that they had been discussing.

This was our fun meeting of the year, but still there were opportunities for learning something new. It seemed to bring the group closer together and everyone is still talking about it.—Frank M. McGeary, *Secretary-Treasurer*, c/o Motion-Picture Laboratories, Inc., 781 S. Main St., Memphis 6, Tenn.

The Nashville Section met on September 17 at the Southern Bell Conference Room with an attendance of 20. Guest speaker George Gill of Century Lighting Company discussed "Lighting for Television."

The meeting began with a showing of Academy Award nominee, *City of Gold*, produced by the Canadian Film Board. The film was a fine example of the use of still photographs in a motion picture.

Mr. Gill's paper on television lighting included problems of the past, situations encountered today, the predictions for the future. He gave an illustrated (slides) talk on a television studio in Miami in which his company had installed a rail lighting system. The slides included diagrams, blue prints, and shots of the studio in use which illustrated well the rail system.

A question period followed Mr. Gill's formal presentation. During this time he gave his reasons for the use of particular details in his setup (e.g. a 14-ft grid) and compared notes with the television people present at the meeting as to the use of dimmers, etc., in their setups. Although his work at the studio was intended as a demonstration for television, it has application to and interest for motion-picture people as well.

Coffee and doughnuts were served before and after the meeting. Some of the members stayed for further discussions with Mr. Gill.—Frank M. McGeary, *Secretary-Treasurer*, c/o Motion-Picture Laboratories, Inc., 781 S. Main St., Memphis 6, Tenn.

The New York Section met September 14 at the World Affairs Center Auditorium with an attendance of 65. Don Malkames, a director of photography, addressed the group. His subject was "Antique Motion Picture Equipment."

Mr. Malkames, although prominent as a director of photography, is also well known for his collection of antique motion-picture equipment. He opened this meeting with a 3-reel motion picture illustrating many of the unique items in the collection maintained in his home. After the film presentation he displayed and demonstrated several of the older and rarer cameras from his collection. He discussed some of the earliest beginnings of the motion-picture art and described some of the old techniques and equipment used.

After the coffee break and social period, an interesting question-and-answer session, in which many members of the audience participated, was enjoyed.—James W. Kaylor, *Secretary-Treasurer*, c/o Movielab Film Labs, Inc., 619 W 54 St., New York 19.

The San Francisco Section met September 13 at the Studios of KGO-TV with an attendance of 20. Robert J. Nissen, chief engineer, KQED (San Francisco's noncommercial television station) was the guest speaker. His subject was, "D-C Restorers in Television Receivers."

Mr. Nissen for some years has been carrying the fight to various manufacturers in an attempt to have d-c restorers included in modern receivers. With a series of slides the basic problems of the two types of popular restorers were explained and the reasons for their need shown. (For a complete technical explanation of their operation see the August 1960 *Journal*, pp. 521–527.)

In addition to the slide lecture a live studio camera chain was fed into a Conrac monitor, which can have its restorer switched on or off. The change in

the picture quality was very pronounced in the off position. A series of cards going from white to black was shown under both restorer conditions. The lack of black under restored conditions became very apparent. A question-and-answer period followed the lecture-demonstration.—Frank Mansfield, *Secretary-Treasurer*, 57 Stoneyford Ave., San Francisco 24.

The San Francisco Section meeting of October 11 took the form of a tour through the Radio and TV Broadcast Departments of the John O'Connell Vocational School. About 20 members attended.

Ken Nielsen and Ken Dragoo, instructors in charge of the Radio and TV Broadcast Departments, were the speakers of the evening. Mr. Dragoo described how the department was first set up and the equipment that was used. Mr. Nielson conducted the members on a tour of the studios where image-orthicon studio cameras and complete film pick-up equipment were in operation. In addition to the television equipment the students also operate an FM station (KALW) on a regular schedule. —Frank Mansfield, *Secretary-Treasurer*, 57 Stoneyford Ave., San Francisco 24.

The Rochester Section met jointly with the Society of Photographic Scientists and Engineers on September 30 to hear guest speaker I. C. Abrahams of General Electric discuss a new and interesting system of "thermoplastic recording." The attendance by a record crowd of 288 was an indication of the interest in this subject.

Thermoplastic recording can be briefly described as a system which combines the processing speed and versatility of magnetic recording and the storage capacity of photography. Information is written at extremely high density by means of an electron beam on a film consisting of a low melting thermoplastic material. The information can be projected as a black-and-white or full color image, or can be converted to an electrical signal. The tape, which is processed by quick heating and cooling, can be readily erased and reused.

Mr. Abrahams presented a very good off-the-cuff account of the system and demonstrated one means of read-out of the recorded image by using a 16mm projector with a schlieren optical system.

To start the meeting, a very delightful 16mm color film produced by British Transport Films entitled *Journey Into Spring* was shown. Prior to the meeting, Chairman Connor held a meeting of the Section officers to discuss plans and programs for the balance of the year. Several officers and guests adjourned to have a social hour and dinner with the speaker of the evening.—W. G. Hill, *Secretary-Treasurer*, 10 Hillcrest Ave., Binghamton, N.Y.

Abstracts

Abstracts from other Journals, chosen for importance and timeliness, are published in the *Journal* from time to time. The greater number of these abstracts are translations, chiefly from the U.S.S.R., and made available by the *Kodak Monthly Abstract Bulletin.*

The subject areas are grouped below:
Aerial Photography
Cameras and Equipment
(Except High-Speed)
Color Photography and Color Development

AERIAL PHOTOGRAPHY

The Resolving Power of Objectives for Aerial Photography (in Russian), E. G. Obraztsova, *Sbor. Stateĭ Leningrad. Inst. Tochnoĭ Mekh. i Optiki.*, No. 27, 148–151, 1958.

Results are given for the analysis of material, over a period of ten years, on the photographic resolving power in the center of the field of a series of wide-angle objectives from the Northwest Aerogeodesic Enterprise: Russar-30 120mm, $f/7.2$; Russar-33 100mm, $f/6.8$; Russar-29 70mm, $f/6.8$; and Russar-39 35mm, $f/6.8$. The resolving power of the specimens on Pankhrom-10 film varied within the limits, $\pm 9\%$. A decrease in the longitudinal spherical aberration from 2.4 to 0.9 mm at a relative aperture of $f/6.8$ leads to an increase in the resolving power from 28 to 36 lines/mm. On stopping the lens down to $f/9$, the resolving power rises by 16 to 30%, and further stopping down to $f/16$ gives practically no change. Graphs and tables show the relation between resolving power and the magnitude of longitudinal spherical aberration.—S. C. G. (Translated from *Referat. Zhur., Fiz.*)

Rapid Methods of Processing Aerial Photographic Materials

A short review is given of a number of methods of rapid processing of photographic materials suitable for aerial photography. Data are given on methods connected with the use of viscous (containing agar-agar, starch, polyvinyl alcohol or Tylose) or alcoholic ethylene glycol, (glycerin)—aqueous processing solutions for processing aerial photographic paper. At temperatures of 40–60 C., the time of processing prints with satisfactory discrimination of detail requires 20 to 30 sec. For obtaining aerial negatives simultaneously with positives, it is possible to use a rapid one-stage development of the Land type, while a better result is given with the so-called "deep" variant, in which the positive image is formed, not in the surface of the developer on the positive material, but in a special receptive layer of a film-forming substance which is insoluble in water. At 20C., development of the negative is, in general, finished after 1 min., and the positive after 2 to 3 min. The negative is characterized by low values of gamma (0.4–0.45) and D_{max}. (0.85–0.95), while the positive in gamma and D_{max}. directly corresponds to glossy paper No. 2 and exhibits a fairly low resolution (22 to 24 lines/mm), so differing from the negative. A defect of this method of obtaining

the image is the unavoidable narrowing of the useful exposure range. (S. C. G.)—[Translated from *Referetivnyi Zhur., Fiz.*] V. A. Veidenbakh. *Trudy Labor. Aerometodov. Akad. Nauk. S.S.S.R.,* 7:32–6, 1959 (in Russian).

CAMERAS AND EQUIPMENT (Except High-Speed)

Some Methods of Eliminating Camera Flicker, I. A. Chernitskiĭ, *Tekh. Kino i Televideniya, 4:* 58–60, Mar. 1960.

Camera flicker is noticed in projection as a periodic variation in screen brightness and is due to a periodic variation in the exposure of the film in the motion-picture camera. In this paper, attention is directed to only one of the possible causes, namely, the uneven rotation of the shutter. A method of recognizing this defect and several possible methods of eliminating it are described.—S.C.G.

Russian Pat. 133,962. An Optical System for Panoramic Cinematography With Several Fixed Objectives (in Russian), A. A. Lapauri. Filed Apr. 5, 1956. Abstracted in *Tekh. Kino i Televideniya, 4:* 88, Mar. 1960.

A prismatic mirror device is proposed consisting of several uniform reflecting faces disposed in the form of a pyramid. The device turns the light beams going to each of the objectives through 90° and makes the virtual images of the pupils of all the objectives, constantly focused for infinity, coincide in a single point. It is shown that a camera with the optical system described with a constant position of all the elements, and adjusted for the coincidence of the virtual images of the centers of the pupils of all the objectives, ensures the absence of overlapping and splitting in the general panoramic picture.—S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

Russian Pat. 177,027, An Optical System for Panoramic Cinematography (in Russian), A. A. Lapauri. Filed July 29, 1957. Abstracted in *Tekh. Kino i Televideniya, 4:* 88, Mar. 1960.

In known optical systems for panoramic cinematography with the aid of several objectives, the optical axes of the objectives intercept in a general point situated in the object space, as a consequence of which the centers of the objectives do not coincide among themselves. This leads to overlapping or loss of part of the space where the images coincide.

By using mirrors or prisms in front of the objectives, it is possible to bring about coincidence of the virtual images of the objective pupils, but only for one focal distance; passing beyond the focus of the objectives gives once more a noncoincidence, owing to the change in magnitude of the horizontal angle of the field of view of the objectives. To keep the angle horizontal, it is proposed to focus not by the motion of the objectives along the optical axis, but by changing the main focal length of the objective. For this purpose objectives are used having movable lenses in the objectives themselves or in the back components.— S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

Russian Pat. 113,918. An Anamorphotic Direct-Vision Viewfinder for Motion-Picture Cameras, F. S. Novik. Filed June 23, 1955. Abstracted in *Tekh. Kino i Televideniya, 4:* 87, Mar. 1960.

In an anamorphotic direct-vision viewfinder for a motion-picture camera, consisting of an objective with cylindrical components and an ocular with spherical components, symmetrical systems of the aplanat type with crossed cylindrical lenses are used as components of the objective. It is shown that this leads to a minimum of optical defects, for example distortion, meridional curvature, etc., thus improving the image quality in the field of view.—S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

Russian Pat. 117,993. A Wide-Angle Viewfinder for a Motion-Picture Camera, M. M. Rusinov and F. S. Novik. Filed Nov. 20, 1957. Abstracted in *Tekh. Kino i Televideniya, 4:* 88, Mar. 1960.

A motion-picture camera viewfinder is proposed in the form of an optical system projecting onto a matte screen an image of the object which is being photographed, observation of this image being made through the back of the screen by means of an ocular. In particular, the objective of the viewfinder is in the form of a plano-parabolic lens, which widens the field of view up to about 120° and allows the viewfinder to be used for photography on wide-format film. It is shown that, when the plano-parabolic lens is made from K-8 glass having a refractive index of 1.5163, distortion of the edge of the field does not exceed 3.5% for an angle of 120°.—S. C. G. (Translated from *Tekh. Kino i Televideni a.*)

Russian Pat. 117,977. A Wide-Angle Viewfinder for a Motion-Picture Camera, F. S. Novik, V. I. Omelin and M. M. Rusinov. Filed Oct. 9, 1957. Abstracted in *Tekh. Kino i Televideniya, 4:* 87–88, Mar. 1960.

The proposed wide-angle viewfinder for a motion-picture camera consists of an aggregate of three single parallel optical systems forming, for all the systems, one general image of the taking objective on a matte surface, observation of the back of the ground-glass screen being made through an ocular. To obtain an angle of vision of the order of 120–150°, half-pentaprisms are placed in front of the objectives of the extreme optical systems, and a compensating plane-parallel plate is placed in front of the objective of the middle optical system. During exposures with vertical panning, distortion of horizontal lines may occur in the viewfinder. This distortion is eliminated by rotating both half-pentaprisms around the optical axis.—S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

Efficient Use of Electrical Energy in Motion-Picture Studios (in Russian), V. G. Pell' and Kh. A. Rabinovich, *Tekh. Kino i Televideniya, 4:* 22–27, Apr. 1960.

There is at present, in the Soviet Union, a drive for the more efficient use of electrical power. A survey is made of the use of electricity in lighting for motion-picture studios and a number of recommendations are made for increasing the efficiency.—S. C. G.

Some Aspects of Illumination in Underwater Cinematography, I. B. Gordiĭchuk, *Tekh. Kino i Televideniya, 4:* 62–69, May 1960.

In underwater cinematography by natural light, the intensity of illumination is, in general, below that at the surface, owing to the optical properties of the water. The factors discussed are the inclination of the sun's rays to the surface of the water, and the spectral absorption, scattering, and transparency of the water. As a result of these factors, the lighting conditions vary according to depth. In addition, the thickness of the water between the camera objective and the subject being photographed must be taken into account. Some recommendations for underwater cinematography are given.—S. C. G.

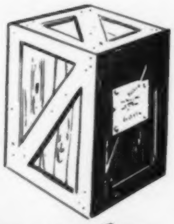
Technological Developments in the Manufacture of Motion-Picture Apparatus at the Lenkinap Factory, S. M. Kuznetsov and R. M. Kasherininov, *Tekh. Kino i Televideniya, 4:* 56–61, May 1960.

The Lenikinap factory is playing an important part in the present drive for the extension of the motion-picture network in the Soviet Union. Modernization is also called for and it is predicted that, within three years, the factory will have no lines first produced earlier than 1959, except for spare parts for existing machines. The year 1959 saw the introduction of the regular production of new printers, processing machines, film-restoring machines, and sound-recording apparatus. Further items exist as prototypes and experimental models. Attention has been paid to improving the quality and finish of apparatus. At present, considerable attention is being paid to the development of apparatus for wide-format (70mm) cinematography. On the other hand, apparatus for narrow-gage cinematography, which has been somewhat neglected in the Soviet Union, is being developed. Some aspects of the collaboration with other organizations, such as the NIKFI Research Institute and the Central Construction Bureau of the Ministry of Culture, are discussed.—S. C. G.

COLOR PHOTOGRAPHY AND COLOR DEVELOPMENT

Spray-Dyeing of Matrices in the Imbibition Printing of Color Films (in Russian), G. G. Bagaeva, I. B. Blyumberg and A. S. Fedoseeva, *Trudy Leningrad. Inst. Kinoinzhener,* No. 5, 219–225, 1959.

A description is given of experimental equipment for the spray-dyeing of matrices, with results of an investigation of the effects of separate factors (dye concentration, temperature of solutions, conditions of applying the dye solution) on the density. It is concluded that spray-dyeing of the matrices is a much more effective method than dyeing by bathing in a solution of the dye.—S. C. G. (Translated from *Tekh Kino i Televideniya.*)



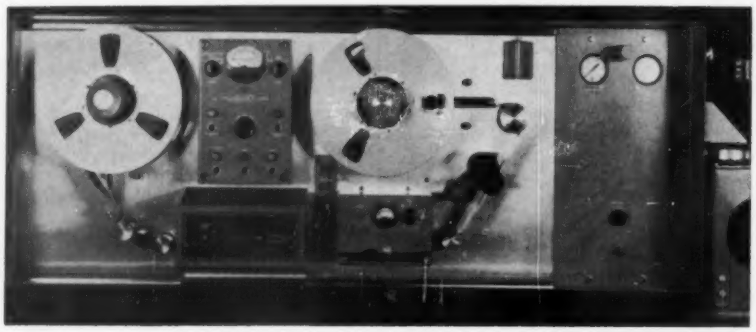
new products

(and developments)

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.

A high-intensity light source for photographic motion studies has been announced by Avco Research and Advanced Development Division, 201 Lowell St., Wilmington, Mass. Originally developed to study hypervelocity flights of model nose cones for the Air Force Titan and Minuteman ICBMs on the Avco Ballistics Range, it is designed to be incorporated into instrumented shadowgraph and schlieren systems or to be used alone, in a manner similar to the open-shutter flash bulb technique, in a basic shadowgraph system for laboratory work. Four models are available to provide spark light duration from 0.3 to 1 μsec. Size of the point light source varies in diameter from 0.015 to 0.060 in., depending on the energy level which may range from 2 to 20 joules. The spark pulse may be synchronized with a Kerr cell shutter. A voltage pulse is also produced to initiate other measuring devices. The unit is contained in a cylindrical package, 12½ in. long, 5 in. in diameter, with a coaxial discharge path. The outer case, which serves as an r-f shield, is designed so that when the unit is positioned, the component package may be removed, adjusted and returned to the case without disturbing the optical alignment. In operation the coaxial capacitor is discharged in an air gap. Designated the Type LS-020 Package Light Source, it is priced at approximately $900.

A pneumatic powered shock test machine for production testing of small electronic components has been announced by the Industrial Products Subdivision, Avco Research and Advanced Development Division, 201 Lowell St., Wilmington, Mass. The machine is designed to handle specimen loads up to 30 lb and to produce all shock pulses required for testing electronic components with an impact velocity of up to 192 in./sec. The machine has no superstructure and relies on control of air pressure into and out of a pneumatic cylinder. The specimen carriage is connected to the pneumatic cylinder by a guide rod and in operation is raised and propelled downward by a discharge of air. The machine, called the Avco SM-005 Shock Machine is composed if five major assemblies: base, brake, carriage, control panel and actuator.



A video-tape recording of the underside of giant icebergs in the Arctic Circle has been made possible by the development of small (20 in. by 20 in. by 100 in.) transistorized recorder, a joint effort of RCA and the U.S. Navy, specially designed to fit in the torpedo room of the *Seadragon*, the nuclear submarine which rode under the ice on its way to the North Pole. The recorder uses a 2-in. tape developed by Minnesota Mining and Mfg. Co. The tape, on 10½-in reels moves past a normal video scanning type recording head at 15-in./sec. Played back at the Navy Electronics Laboratory in San Diego, Calif., on an RCA, TRT-1A recorder (the type used by commercial television stations), the recorded under-ice characteristics can be studied by crews being trained for polar navigation.

A new high-vacuum tube, type WX-4047, for intensifying light radiation by electronic means is now produced by Westinghouse Electric Corp., Electronic Tube Div., P.O. Box 284, Elmira, N.Y. The new tube, the Astracon image amplifier, produces an image of reduced size whose brightness is increased by a factor of 2500 for actinic blue input radiation and of 1000 for input radiation at a color temperature of 2870 K. In operation, incoming radiation impinges on a 5-in. photosurface which converts the light image to an electron image. Deposited directly on the internal surface of the polished bulb face, the photocathode is capable of functioning as an integral part of an external optical system. After conversion, the electron image is focused and accelerated toward an aluminum-backed phosphor screen. Through the use of short-persistence P15 phospher in the tube, the brightness decays to 10% in 2.0 μsec. Input resolution is 75 line pairs/in. The threshold for imaging is 10^{-7} ft-c. Maximum ratings are 30 kv (anode screen to photocathode) and 1-ma peak pulse anode screen current. The tube weighs 6¼ lb, has a maximum diameter of 8 11/16 in. and is 15¾ in. long. The tube and its uses were the subject of Paper No. 24, by A. E. Anderson and G. W. Goetze at the 5th International Congress on High-Speed Photography.

A television zoom camera which incorporates a modified design of the Taylor-Hobson Varital III Zoom Lens has been developed jointly by the British Broadcasting Corp. and Taylor, Taylor and Hobson Division of Rank Precision Industries Ltd., 37–41 Mortimer St., London, W.1. The camera has been announced as the first with an integral zoom lens contained inside the camera body. The focal range is from 2 in. to 40 in. The compact construction was made possible by the use of mirrors to fold the path of light behind the lens. This enables the lens and the image-orthicon tube with its electronics to be arranged side by side rather than in the usual "in line" arrangement, thus keeping down the overall length of the assembly.

The lens system has four separate ranges of viewing angle and on two of these the minimum distance at which objects can

be focused is as little as 2 ft 6 in. Selection of the required range can be carried out while the camera is on transmission. The electronic components of this prototype camera are those of the Marconi Mark III image orthicon used in many of the BBC television remote and also in many BBC television studios. The camera can therefore be used in place of one of the conventional cameras under a wide range of remote broadcasts and studio conditions.

The Sachtler and Wolf Double-Gyro Tripod, designed especially for the Arriflex 35, has been introduced in the United States by Cine 60, Film Center Bldg., 630 Ninth Ave., New York 36. The gyro mechanism is designed for the greatest possible control of panning and tilting action, with a quarter turn of the lever for each gyro disengaging the horizontal and vertical gyros. The company, which has been announced as developing and importing accessories especially for Arriflex, but also for other motion-picture cameras, has also introduced a shoulder tripod designed to fit conventional motion-picture cameras. For the Arriflex 35, a special adapter plate is supplied which provides an opening for the hand-grip motor. Used in photography of sports or wildlife, a battery may be attached to the tripod. The shoulder tripod is priced at $89.

A closed-loop TV transmission system employing transistors in the repeater and terminal equipments has been constructed by research engineers of Bell Telephone Laboratories. Designed to reduce power requirements and size of apparatus, the system operates on an experimental basis between Holmdel and Murray Hill, N.J. Reported advantages of the system include eliminating the necessity for a local power supply because operating power can be transmitted over the coaxial cable. Thus, small amplifiers can be mounted on telephone poles or installed underground without complex housings. In the Murray-Hill—Holmdel demonstration, the three general circuit classifications for the hookup were the transmitting terminal, the cable repeaters, and the receiving terminal. A monitor was arranged so that it could be connected to either the input or the output of the system. The experiment showed the video response to the 6-mile system to be down by less than 2 db at 6 mc.

A photoemissive material developed by Westinghouse Electronic Tube Division under a research contract with the Bureau of Ships is of bi-alkali type, made by combining sodium and potassium with antimony. (The major constituent of many photoemissive materials is cesium.) Developed especially for use in such devices as imaging and photomultiplier tubes in which photosurfaces convert radiant energy into electrical energy, the material is reported to maintain a high level of sensitivity over many hours of operation at 250 F and is expected to permit operation of these photosurfaces over periods up to 140 hr. It was also found that during operation in total darkness the "dark current" (residual current) was significantly less than that noted for conventional materials. In work with a number of experimental tubes this material has been applied as a semitransparent surface over a glass substrate. Photoresponse values up to 80 μa/lm were recorded with response uniform within 10% over the useful cathode area.

Key TV, developed by TelePrompTer Corp. to permit television viewers to "talk back," was exhibited at the Convention of the National Community Television Association held in Miami Beach in June. The viewer presses a button which registers at a central control point, opening communication to the broadcaster. A limited use for educational TV examinations and opinion polls has been suggested.

A damping diode, tube type 6CQ4, for use in horizontal deflection circuits of television receivers has been announced by Electronic Tube Division, Westinghouse Electric Corp., P.O. Box 284, Elmira, N.Y. Rated at 5500 v (peak) and 190 ma (average plate current), it replaces some older types with lower ratings. Design features include a glass-ring plate suspension which eliminates mica arc over; a mechanically anchored spiral insulator between heater and cathode to permit higher heater-to-cathode voltage ratings than do cemented assemblies; and a high-voltage tube base in which base pins are mounted in wells to increase between-pin insulation.

Two new power supply systems have been announced by Foto-Video Electronics, Inc., 36 Commerce Rd., Cedar Grove, N.J. The V-410 all-transistor regulated power supply system includes a semiconductor rectifier-filter and an all-transistorized regulator. The P-30-36, 30-amp, 0–36 v regulated power supply has silicon rectifiers and an all-transistorized regulator. It is smaller and lighter in weight than power supplies using selenium rectifiers and magnetic amplifiers. Panel-mounted controls include 4-range output voltage switch, vernier voltage control, circuit breaker for overload protection and power switch, and pilot light. A volt-

meter and an ammeter are mounted on the front panel.

Multiple-speed transmission units developed by Autotronics, Inc., P.O. Box 208, Florissant, Mo., consist of two or more gear trains with friction disc electromagnetic clutches inserted between them. The desired speed ratios are produced by energizing one or more clutches to couple the gear trains in appropriate combinations. The clutches are electrically controlled, permitting speed changes to be made automatically by a sequencing switch as well as manually with pushbuttons. They can also be controlled remotely by a direct wire hook-up or through a telemetering system. Presently available are 2, 4, 15, and 30 speed units with dimensions ranging from 3 in. in diameter to $4\frac{1}{2}$ in. and $2\frac{5}{8}$ in. to $7\frac{1}{4}$ in. in length.

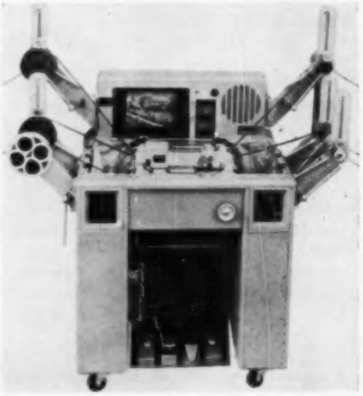
A close-up mounting stand that allows a direct-wire television camera to be used in connection with microscopes, close-up work, demonstrations, or the scanning of a fixed area has been announced by Argus Cameras, Inc., 405 Fourth St., Ann Arbor, Mich., a marketing subsidiary of Sylvania Electric Products Inc., a subsidiary of General Telephone and Electronics Corp. The stand is designed to permit the vertical mounting of a TV camera, by the addition of a particle screen within the camera to protect the vidicon tube. It is priced at $179.95. Accessories include a lighting kit containing two light fixtures and bracket, priced at $24.95 and a kit consisting of four extension tubes with lengths ranging from 5 to 40mm priced at $16.95.

The Ansco Automatic Recording Microdensitometer is designed for measuring and recording transmission and reflection densities of micro images in the field of photography and the graphic arts where critical measurements of acutance, granularity, resolution, and related studies are essential to the evaluation of image quality. Developed by Ansco Division, General Aniline & Film Corp., Vestal Parkway East, Binghamton, N.Y., the instrument consists of a traveling stage projection microscope with a photomultiplier tube for measuring the light in the projected image. The limiting aperture, which can be adjusted to determine the reading area in the projected image plane, is immediately in front of the phototube. The phototube is operated in conjunction with an Ansco Model 12A Densitometer circuit providing an output linear with optical density which is recorded on a strip chart recorder.

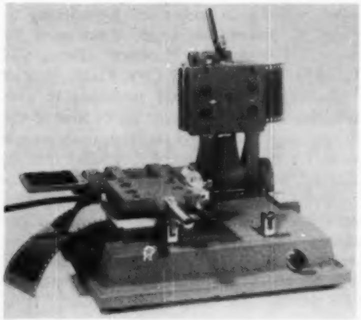
Three dimensional, pressure-sensitive letters for titling that can be easily used by the amateur photographer have been announced by Hernard Mfg. Co., 21 Saw Mill River Rd., Yonker, N.Y. The letters can be coated with a special adhesive and applied to nonabsorbant objects. Sets are priced at $4.95 and are available with $\frac{3}{8}$-in. letters, copperplate style, or $\frac{3}{4}$-in. Gothic Condensed.

Traffic problems in the Lincoln Tunnel between New York City and New Jersey are nearer solution because of the installation of a closed-circuit TV system to provide comprehensive traffic control information. A closed-circuit camera on top of the 35-story McGraw-Hill building in New York which looks over the New York approaches to the tunnel is operated from a New Jersey traffic control center. Port of New York Authority officials are enabled to study traffic patterns in order to vary the use of the center tube of the tunnel.

A ball-socket, quick-leveling Arri 16 Hi-Hat has been announced by Birns & Sawyer Cine Equipment Co., 6424 Santa Monica Blvd., Hollywood 38. The hemispherical collar is adjustable and is designed to accept the Arriflex pan heads, as well as various types of ball adapters. It is priced at $34.00 and is described in Birns & Sawyer Catalogue as No. 1123.



The Acmade Mark II Editing Table, manufactured in England by Acmade Ltd. and distributed in the United States by Intercinema Corp., P.O. Box 3452, New York 17, is available from Florman & Babb, Inc., 68 W. 45 St., New York 36. The machine features continuous (rather than intermittent) movement. It can be operated at variable or sync speeds with instant-stop foot or hand controls. Projected picture size is 8 by 6 in. The unit is supplied in 16mm and/or 35mm with separate optical and/or magnetic track or in any combination and with extra tracks. The complete machine is priced at $2975.



The Traid 170, a portable hot splicer for 70mm motion-picture film, has been announced by Traid Corp., P.O. Box 638, Encino, Calif. The splicer is designed with full-fitting pilot pins to make splices 0.080 in. wide between perforations. Thermostatically heated cutter blades are made of hardened chrome steel and the scraper block is removable. The splicer weighs about 15 lb. The power requirement is 115 v a-c. It is priced at $745. Models are available for ASA Type I or Type II perforations or for 55mm and 65mm films.

A new Rapid Spray Film Processor for 16mm or 35mm black-and-white motion-picture film has been announced by Houston Fearless Corp., 11827 W. Olympic Blvd., Los Angeles 64. Speeds up to 150 ft/min are reported for positive film and 100 ft/min for negative, with a complete processing cycle from dry to dry in less than 5 min. An improved spray bar has been incorporated in each of the three chambers for uniform processing of all types of black-and-white film under varying conditions of speed and temperature. Other improved features include a direct film drive incorporating separate gear boxes for each compartment, automatic film tension control, Thermistor-type temperature control, two-station, tear-drop-shaped air squeegees and electric tachometer. The machine is constructed of stainless steel. A wax or silicone applicator is optional. If desired, the machine can be equipped to give an archival wash. The price is in the area of $30,000.

A simplified communication system called Scan-A-Graph 500 is a device that transmits and enlarges subject matter that will fit into an 8½ by 11-in. area (16mm film or slides, handwritten or typed copy) so that it is shown on a 27-in. TV screen. Operating without lights or camera, the device, described as a closed-circuit TV transmitter, is used to display flight information at airports and for similar situations where typed or printed material is to be transmitted over a considerable distance. The system has been developed by Television Utilities Corp., a division of Nord, 300 Denton Ave., New Hyde Park, L.I., N.Y.

The Autorac Processall, an automatic processor featuring no-thread loading, has been announced by Oscar Fisher Co., Box 426, Newburgh, N.Y. Designed to process motion-picture film at a speed of 50 ft/min and roll and sheet films and papers at a speed of up to 9 ft/min, the film or paper rolls are wound on take-up reels and sheet films are dropped into a basket. The unit is constructed of passivated 316L stainless steel.

Capacitor reforming service is offered to purchasers of Synctron electronic flash equipment by Electro Powerpacs, Inc., a subsidiary of Hydra-Power Corp., 5 Hadley St., Cambridge 40, Mass., manufacturers of the equipment. Pinpointed as one of the prime causes of electronic flash malfunction, capacitor power loss, mainly due to storage, can be halted and the capacitor restored to effective load level by the use of voltage and amperage reforming units. Two such reformings are offered as a service to purchasers and dealers without charge over a three-year period.

The Sun Gun, a small, compact lighting unit for 8mm motion-picture photography, has been announced by Sylvania Electric Products Inc., a subsidiary of General Telephone & Electronics Corp., 730 Third Ave., New York 17. It is a hand-held, single-source light which can be attached to standard 8mm cameras by means of an adjustable bar. The light uti-

lizes a halogen lamp in a 2$\frac{3}{4}$-in. reflector. Overall dimensions without mounting bracket are 9$\frac{3}{4}$-in. high, 4$\frac{3}{4}$-in wide and 2$\frac{1}{8}$-in. deep. It is balanced for 3400 K. The unit has been announced at the price of $24.95, with replacement lamps prices given as $7.98

A rapid calculator for determining correct lens stops when using filters or shooting above or below normal speeds is offered professional motion - picture photographers without charge upon request to Natural Lighting Corp., 630 S. Flower St., Burbank, Calif. The wallet-size calculator is permanently imprinted on Metalphoto metal and is calibrated to quarter stops.

A special multipurpose truck for motion-picture cameramen has been developed by Jack Frost Electric Co., 234 Piquette, Detroit 2. The truck is said to be vibration-free under loads varying from 1000 to 3500 lb without modifying the truck's springs or suspension system. The truck is equipped with outsize flotation tires supplied by Harmo Tire and Rubber Corp., Detroit, to achieve a jiggle-free ride at speeds up to 100 mph.

Fourteen Christie Arc Lamp Rectifiers, distributed by National Theatre Supply Co., have been purchased by the city of Los Angeles for installation in the new $6 million Memorial Sports Arena. The rectifiers are designed to feed a maximum of 150 kw of d-c power to the banks of Super Arc Lamps that line the arena's overhead circle of suspended catwalks. The type ME4 lamps being used as spots were manufactured by Genarco, Inc., Jamaica, N.Y., to utilize a maximum capacity of 130 amp at 72 v.

A subaudio variable filter, an octave band analyzer and a dynamic microphone accessory kit are among products recently announced by Allison Laboratories, Inc., 11301 E. Ocean Ave., La Habra, Calif. The filter, called Allison Model 201, is designed especially for studies of low-level transient phenomena, such as heart studies, geophysical work, thermocouples and low-frequency vibrations. The filter has high cutoff and low cutoff sections. The multiplier dial is tunable over a range of one octave. The instrument is designed with no transistors, no vacuum tubes and no power supply. The noise level is primarily determined by the pickup in the leads. The distortion introduced by the filter is dependent upon the voltage applied to the inductors. At $\frac{1}{2}$ v the distortion is said to be approximately 0.1%. It is priced at $695.

The octave band analyzer, Model 532, is designed to be a simply operated compact lightweight audio spectrum analyzer. It is used with a sound level meter, tape recorder, microphone preamplifier or similar equipment. It is transistorized, operates with batteries, has low power consumption and has a dynamic range of 66 db. The cost is $425.

The dynamic microphone accessory kit has been made especially for operation with the Model 532. The kit consists of a dynamic microphone, adjustable tripod, 15 ft of cable and a matching transformer. It is priced at $135.

The MX-35, a compact 4-position, 2-channel mixer has been announced by Ampex Professional Products Corp., 934 Charter St., Redwood City, Calif. Special coupling connectors are provided to give additional facilities where up to four of the mixers can be coupled together with overall master gain controlled by the last unit in the system. Each mixer position has a reset indicator which permits return to a previous level and is supplied with a key switch which permits feeding up to four microphones and two high-level line inputs to either the left or right output, or divided equally into both outputs. It is priced at $395. Also recently announced, the Model 354 recorder is designed specifically for the recording and reproduction of sterophonic sound.

A 3-speed recorder, Model G-258/A, which weighs 13 lb and records for 10 hours on one 5-in. reel of $\frac{1}{4}$-in. magnetic tape, has been announced by American Geloso Electronics, Inc., 251 Park Ave., South, New York 10. The machine records at 3$\frac{3}{4}$, 1$\frac{7}{8}$ and $\frac{15}{16}$ in./sec. It is priced at $199.95.

The Ecco-Fonic Accompanist, a development of Ecco-Fonic, Inc., 905 S. Vermont, Los Angeles, is a device to permit a singer or musician to control the amount and volume of the echo, the span of delay of the echo, and the amount and volume of the reverberation. In operation the microphone is plugged in and the controls adjusted by the musician. Two models are available, a portable, professional model incorporating a 15-in./sec tape recorder with a repeating memory cartridge, and a studio model. The studio model incorporates two tape recorders with dual endless tape loops operating at either 15 in./sec or 30 in./sec with separate motors on separate decks. Price range of the smaller model is expected to be from $360 to $400. Price of the studio model will be under $1700.

A magnetic recorder conversion unit, consisting of recording amplifier, connecting cables and head and mount assembly to fit most 16mm optical sound projectors, has been announced by Greg, Box 11, East Side Station, Binghamton, N.Y. The recording head leads the picture by 28 frames; 4 to 8 frames separate it from the erase head. Described as a professional quality unit, it is recommended by the manufacturer for use by "serious amateurs, schools, churches, industry and government." It is priced at $185. A playback-only conversion unit is marketed at $99.50.

Pressure shoes of nylon are installed on RCA motion-picture projectors for longer life and gentler film handling. An announcement by RCA Audio Products Marketing reports that the use of nylon instead of metal for pressure shoes has been found to provide quieter projector operation. It is also reported that the new D Series of RCA projectors have a one-piece intermittent gear and cam assembly.

employment service

These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Educational TV and Motion-Picture Administrator and Consultant. Experienced in every phase of ETV administration, programming, production and teaching, open and closed circuits. Also broad background in mass communications; Ph.D. Consultant on design and use of TV and film equipment, communications curricula, instruction by and for TV. Design of studios, either new building or revamping any size present space. Box 1143, Jacksonville Beach, Fla. CHerry 6-2269.

Physicist. First class honours graduate. British Subject. More than 10 yrs experience various high-speed photographic techniques applied to ballistics. Recently Government Project Officer for major component of British-designed missile. Desires position U.S.A. Write: John E. Brickell, P. O. Box 1370, Nassau, Bahamas.

Manager-Administrator. Presently with large missile manufacturer engaged in missile R&D and production. Present position (6 yrs) as Head of Photographic Dept. engaged in all phases commercial, industrial and scientific photography involving still, motion and graphic arts media. Eleven yrs experience teaching and administering scientific photographic organizations. Successful experience in design and utilization of camera pods and systems for use on ballistic missiles. Age 36, BS and MS degrees, seeking challenging position with organization engaged in R&D and/or production in missile of space vehicle field. Confidential resume on request. Write: MHB, 105 East 30 St., Austin 5, Texas.

Sound Recording Technician. 26 yrs experience recording on tape, disc and film; mixing, dubbing and technical background in recording techniques; understanding and know-how of recording problems. Background in radio, television, recording and motion pictures. Administrative and executive abilities. Member AES and active member SMPTE. Free to travel. Write: Alfred M. Zemlo, 421 Haskell St., Beaver Dam, Wis. TUrner 5-4039.

Writer, Director, Cameraman available for special Civil War Centennial projects. 14 yrs experience in all phases motion-picture and TV work. Writing credits in national magazines, trade journals and films. Know and have written on Civil War subjects and locations. Will handle assignments for producers working on films or presentations for upcoming Centennial Celebration. Write R. Krepela, P.O. Box 7331, Atlanta 9, Ga.

Cameraman. Extensive cine and still experience in documentary training films, photo-optical instrumentation, high-speed and theatrical production. Also experienced in cutting and all phases of motion-picture laboratory work. Designed and equipped motion picture laboratories for industrial firms. Recently completed overseas assignments in the British West Indies and South America. Will consider any position in photography that will enable me to utilize past experience. Will relocate to any area. For further details write or call: Irwin M. Black, 765 West Calle Lerdo, Tucson, Ariz., AXtel-4-4227.

Positions Available

Writer-Director—Films. Requires creative approach to educational medical scripts aimed at physicians and allied audiences. Both pure educational and product-oriented films are produced and distributed through company library. Challenging and rewarding career opportunity with all the fringe benefits of a leading company. If you have the qualifications required, please send resume which should include film credits and salary desired, to Personnel Dept., Wyeth, Box 8299, Philadelphia 1, Pa.

Laboratory Technician. Opportunity for expert technician with complete all-around knowledge, for motion-picture laboratory equipped for Ansco reversal and Eastman Kodak negative and positive. Salary and bonus, opportunity to invest. Universal Color Studio, 136 West 32 St., New York 1.

Motion-Picture Production Worker. Opening exists for talented motion-picture and filmstrip production worker in educational organization located Tidewater, Virginia. Required would be good smattering of experience and comprehension of all elements of creative writing, some motion-picture camera work, supervision of filmstrip production and participation in many phases of motion picture production. Quality of work rather than quantity is considered most important. Permanent position, liberal benefits including group hospitalization, life insurance, free medical service, free retirement. Send complete résumé to James A. Fuller, Director of Employment Colonial Williamsburg, Williamsburg, Va.

Electronic Engineers. Circuits and systems development and design in fields of broadcast and closed-circuit TV, commercial and military. Transistorized circuit experience necessary. Fastest growing company in field. Many benefits. Participation in ownership available. Foto-Video Electronics, Inc., 36 Commerce Rd., Cedar Grove, N. J. CEnter 9-6100.

Journals Available/Wanted

These notices are published as a service to expedite disposal and acquisition of out-of-print Journals. Please write direct to the persons and addresses listed.

Available

Complete set of Journals from January 1934 through June 1960. Excellent condition. For sale only as a set. Write: Don Norwood, 1470 San Pasqual St., Pasadena, Calf.

Wanted

Jan., July, Sept. and Nov. 1949; Jan and Feb. 1950. Century Lighting, Inc. (Mrs. Levine), 521 W. 43 St., New York 36, N.Y.

Feb., Mar., Apr., June 1934. Mrs. Janet Van Duyn, Librarian, CBS Laboratories, 227 High Ridge Rd., Stamford, Conn.

Journals—Bound volumes. Write: S. P. Solow, Consolidated Film Industries, Inc., 959 Seward St., Hollywood.


HF

Contents — pages 752–786

News Columns

Advertisers

Meeting Calendar

AIEE, API, ONR, IRE, Metallurgical Society, Sixth Annual Conference on Magnetism and Magnetic Materials, Nov. 14–17, New Yorker Hotel, New York.

ASME, Annual Meeting, Nov. 27–Dec. 2, Statler Hilton Hotel, New York.

Royal Photographic Society, Scientific and Technical Group Conference, Dec. 7–9, London.

American Association for the Advancement of Science, Annual Meeting, Dec. 26–31, New York.

Seventh National Symposium on Reliability and Quality Control, ASQC, AIEE, IRE, EIA, Jan. 9–11, 1961, Bellevue-Stratford Hotel, Philadelphia.

ISA, Winter Instrument-Automation Conference and Exhibit, Jan. 16–19, 1961, Sheraton-Jefferson Hotel & Kiel Auditorium, St. Louis, Mo.

American Astronautical Society, Jan. 16–18, 1961, Sheraton Hotel, Dallas, Tex.

IRE International Convention, Mar. 20–23, 1961, New York Coliseum, New York.

ISA, 7th National Symposium on Instrument Methods of Analysis, Apr. 17–19, 1961, Shamrock-Hilton Hotel, Houston, Texas.

89th Semiannual Convention of the SMPTE, May 7–12, 1961, King Edward Sheraton, Toronto.

90th Semiannual Convention of the SMPTE, Oct. 2–6, 1961, Lake Placid, N.Y.

91st Semiannual Convention of the SMPTE, Apr. 30–May 4, 1962, Ambassador Hotel, Los Angeles.

92nd Semiannual Convention of the SMPTE, Oct. 22–26, 1962, Drake Hotel, Chicago.

93rd Semiannual Convention of the SMPTE, Apr. 22–26, 1963, Traymore Hotel, Atlantic City, N.J.

• •

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters and of the Committee Chairmen and Members were published in the April 1960 Journal Part II.

sustaining members

of the Society of Motion Picture and Television Engineers

The objectives of the Society are:

- Advance in the theory and practice of engineering in motion pictures, television and the allied arts and sciences;
- Standardization of equipment and practices employed therein;
- Maintenance of high professional standing among its members;
- Guidance of students and the attainment of high standards of education;
- Dissemination of scientific knowledge by publication.

Progress toward the attainment of these objectives is greatly aided by the financial support provided by the member companies listed below.

Acme Film Laboratories, Inc.
Alexander Film Co.
Altec Service Company
  Altec Lansing Corporation
Ampex Professional Products Company
Animation Equipment Corp.
Ansco
Arriflex Corp. of America
The Association of Cinema Laboratories, Inc.
Association of Professional Cinema Equipment Dealers of New York
  Camera Equipment Company, Inc.
  The Camera Mart, Inc.
  Florman & Babb, Inc.
  National Cine Equipment, Inc.
  S.O.S. Cinema Supply Corporation
Atlas Film Corporation
Audio Productions, Inc.
Bach Auricon, Inc.
Bausch & Lomb Optical Co.
Beckman & Whitley, Inc.
Bell & Howell Company
Bonded Film Storage
  (Division of Novo Industrial Corporation)
Byron Motion Pictures, Inc.
S. W. Caldwell Ltd.
The Calvin Company
Capital Film Laboratories, Inc.
Carbons, Inc.
Oscar F. Carlson Company
Century Lighting, Inc.
Century Projector Corporation
Cineffects, Inc.
Cinesound, Ltd., Canada
Geo. W. Colburn Laboratory, Inc.
Color Reproduction Company
Columbia Broadcasting System, Inc.
  CBS Television Network;
  CBS Television Stations; CBS News;
  CBS Films; Terrytoons
Comprehensive Service Corporation
Consolidated Film Industries
Dage Television Division of Thompson Ramo Wooldridge Inc.
DeFrenes Company
DeLuxe Laboratories, Inc.
Desilu Productions, Inc.
Du Art Film Laboratories, Inc.
  Tri Art Color Corporation
Dupont of Canada, Ltd.
E. I. du Pont de Nemours & Co., Inc.
Eastern Effects, Inc.
Eastman Kodak Company
Edgerton, Germeshausen & Grier, Inc.
Electronic Systems, Inc.
Elgeet Optical Company, Inc.
Max Factor & Co.
Filmline Corporation
Dr.-Ing. Frank Früngel GmbH
GPL Division of General Precision, Inc.
General Electric Company
General Film Laboratories Corporation
W. J. German, Inc.
The Gevaert Company of America, Inc.
Guffanti Film Laboratories, Inc.
Frank Herrnfeld Engineering Corp.
Hi-Speed Equipment Incorporated
Hollywood Film Company
Hollywood Film Enterprises, Inc.
Houston Fearless Company
Philip A. Hunt Company
Hunt's Theatres
Hurley Screen Company
JM Developments, Inc.
The Jam Handy Organization, Inc.
Jamieson Film Co.
The Kalart Company Inc.
  Victor Animatograph Corporation
Kear & Kennedy Engineering
Keitz & Herndon, Incorporated
KIN-O-LUX, Inc.
Kollmorgen Optical Corporation
Labcraft International Corporation
LAB-TV
Robert Lawrence Productions, Inc.
Lipsner-Smith Corporation
M.G.M. Laboratories, Inc.
Magno Sound, Inc.
Mecca Film Laboratories Corporation
D. B. Milliken Company
Minnesota Mining & Manufacturing Co.
Mitchell Camera Corporation
Mole-Richardson Co.
Monaco Laboratories
Motion Picture Association of America, Inc.
  Allied Artists Pictures Corporation
  Buena Vista Film Distribution Company, Inc.
  Columbia Pictures Corporation
  Loew's Incorporated
  Paramount Pictures Corporation
  Twentieth Century-Fox Film Corp.
  United Artists Corporation
  Universal Pictures Company, Inc.
  Warner Bros. Pictures, Inc.
Motion Picture Enterprises, Inc.
Motion Picture Laboratories, Inc.
Motion Picture Printing Equipment Co.
Movielab Film Laboratories, Inc.
Moviola Manufacturing Co.
National Carbon Company, Division of Union Carbide Corporation
National Screen Service Corporation
National Theatre Supply Company
Neumade Products Corporation
Northwest Sound Service, Inc.
W. A. Palmer Films, Inc.
Panavision Incorporated
Pathé Laboratories, Inc.
Photo-Animation, Inc.
Pittsburgh Motion Picture Lab
Precision Laboratories
  (Division of Precision Cine Equipment Corporation)
Prestoseal Mfg. Corp.
Producers Service Co.
Radio Corporation of America
  National Broadcasting Company
  Broadcast and Television Equipment Division
Rank Precision Industries Ltd., G. B. Kalee Division
Rapid Film Technique, Inc.
Reid H. Ray Film Industries, Inc.
Reeves Sound Studios, Inc.
Richardson Camera Company, Inc.
RIVA-Munich
Charles Ross Inc.
L. B. Russell Chemicals, Inc.
Ryder Sound Services, Inc.
Scripts By Oeveste Granducci, Inc.
Snazelle Production Inc.
Southwest Film Laboratory, Inc.
The Strong Electric Company
Sylvania Electric Products, Inc.
Technicolor Corporation
TELIC, Incorporated
Titra Film Laboratories, Inc.
Traid Corporation
Trans-Canada Films Ltd.
Van Praag Productions
Alexander F. Victor Enterprises, Inc.
Westinghouse Electric Corporation
Westrex Corporation
Wilding Inc.
Wollensak Optical Company

The Society invites applications for Sustaining Membership from other interested companies. Information may be obtained from the Chairman of the Sustaining Membership Committee, Ethan M. Stifle, Eastman Kodak Co., Room 626, 342 Madison Ave., New York 17, N.Y.